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The Isochronal Pumping Engine.

The principle of operation of the ordinary governor is well understood in connection with ordinary steam engines, and those informed upon the subject will readily appreciate the difficulty, if not impossibilities, of applying such governors to steam-pumping engines which have no revolving parts.

In pumping engines, nice regulation is of the utmost importance on account of the damage which may result from irregular action. "Isochronal" means "equal spaces in equal times," and the Isochronal pumping engine herewith illustrated, possesses the peculiar property of maintaining a uniform rate of piston travel under varying conditions of power and resistance; in short, it is perfectly self-governing. Our illustration is from an engine having a steam cylinder two feet in diameter and a pump one foot in diameter. The stroke is two feet. The machine is adapted to water works purposes, and any similar work where a uniform motion is desired under all variations of conditions. The Isochronal pumping engine is its own engineer in this respect.

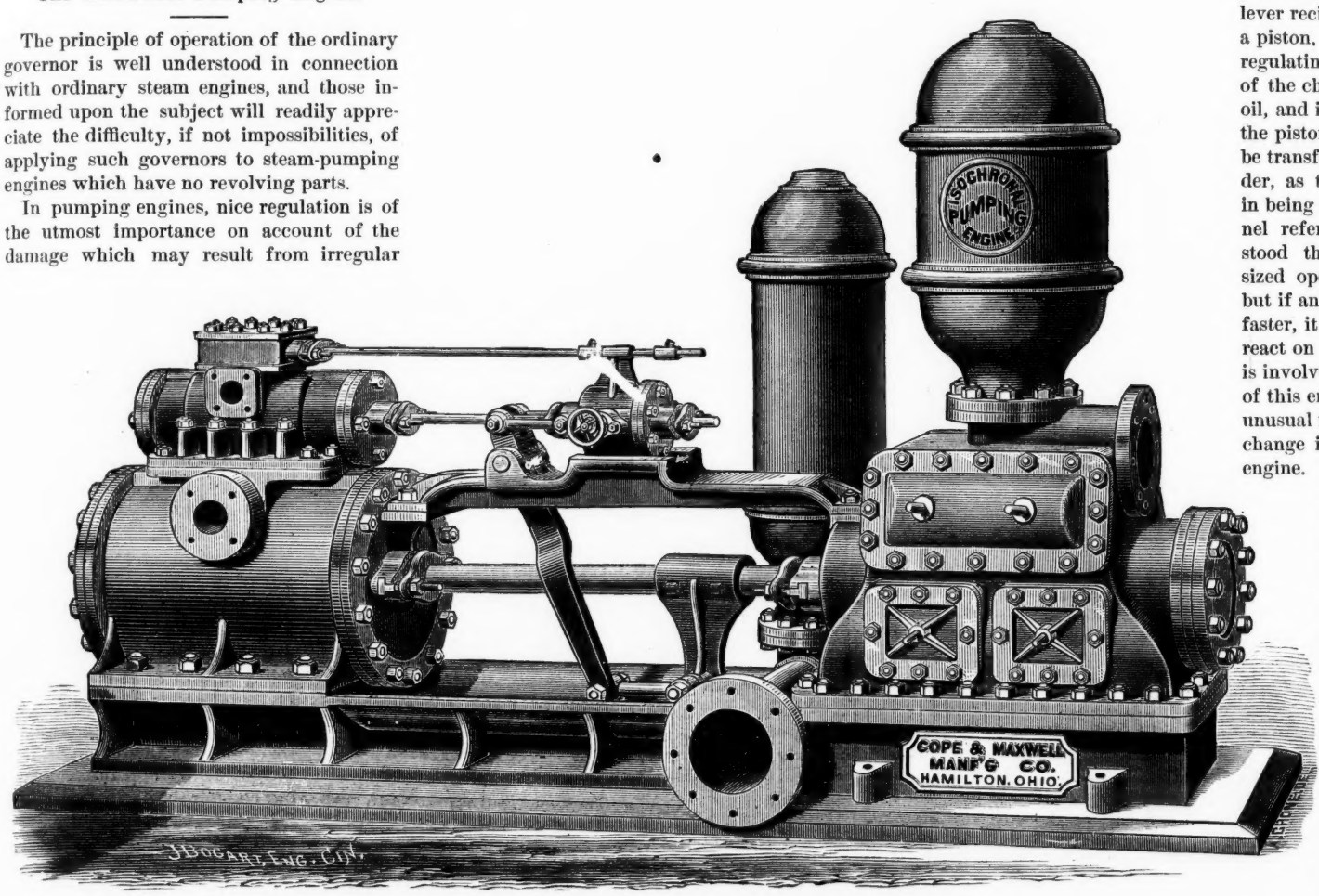


FIG. 1.—THE ISOCHRONAL PUMPING ENGINE (Perspective View).

The means employed for rendering this pumping engine isochronal are so simple, so perfect, and so interesting in principle, that we have thought the matter deserving such a description as will render it better understood among those interested.

In general arrangement this pumping does not materially differ from the ordinary steam pumping engine of similar type; that is to say, the main valve is moved by a small auxiliary engine whose valve is moved by a lever actuated by the main piston rod In the illustration, the small upper rod is the stem of the valve of the auxiliary engine, and the lever upon the main piston rod actuates this stem through the tappet collars *e*, the intervening devices in the neighborhood having no effect upon this function of the lever.

In addition to moving the small valve, the lever reciprocates a short cylinder H, having a piston, a channel from end to end, and a regulating cock L, for altering the capacity of the channel. This cylinder is filled with oil, and it will be readily understood that if the piston within it be stationary, the oil will be transferred from end to end of the cylinder, as the cylinder reciprocates. The oil in being transferred passes through the channel referred to. It should now be understood that liquid will pass through any sized opening, if it is allowed time enough, but if an attempt be made to force it through faster, it will offer great resistance, and will react on the urging medium. This principle is involved in the regulating of the motion of this engine, and is utilized by causing any unusual reaction in the oil cylinder to effect a change in position of the main valve of the engine. Let us suppose that the main has opened one port; that the valve is held in that open position by the pressure of steam upon the auxiliary piston; that the auxiliary piston and the oil piston are, as is the case, united by a rod; and that the channel cock is so set that the oil may shift every ten seconds, and produce just reaction enough to balance the pressure of steam upon the auxiliary piston. The auxiliary piston tend to keep the main valve open, and the reaction of the oil tends to shut the main valve The forces balance and, of course, the main valve remains open. But suppose the resistance of the pump to be suddenly decreased, by the bursting of a main, for instance, then the main piston would be disposed

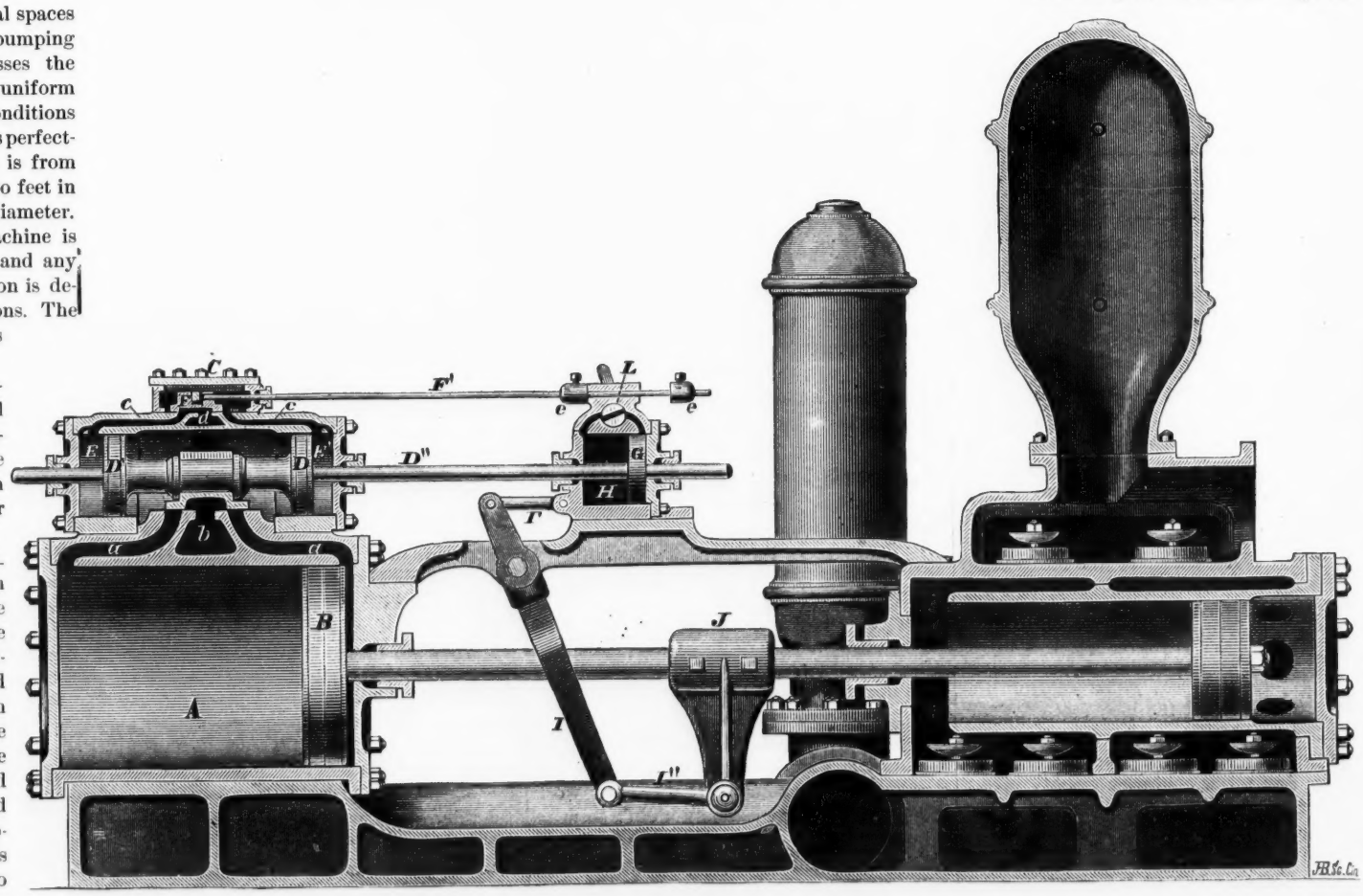


FIG. 2.—THE ISOCHRONAL PUMPING ENGINE (Longitudinal Vertical Section).

to suddenly increase in velocity and, if uncontrolled, to "race."

In this case it will be seen that the oil would be asked to pass through its channel at a quickened rate, a proceeding which, by law, it objects to, and it indicates that objection by an increased reaction on the oil-piston, which is thus caused to preponderate in power over the steam pressure on the auxiliary piston, and to effect a proper closure of the main valve. An increase in pump-resistance tends to slow the motion of the main piston and of the oil cylinder, to reduce the reaction and thus allow the auxiliary piston to effect a proper opening of the main valve. In short, if the main piston by increased motion tends to force the oil through the channel in less than ten seconds' time, the oil-piston pushes the main valve into a more closed position, and checks the tendency; and if the main piston by lagging tends to give the oil more than ten seconds' time to shift, then the oil reduces its reactive force, and allows the auxiliary piston to open the main valve wider and check the lagging tendencies. This rigid exactitude goes on through each stroke, and through every inch of every stroke, and maintains that proper amount of valve-opening which is required for a stroke in ten seconds, or six strokes per minute. The channel-cock being once set for any desired rate of motion, that motion will be constantly maintained spite of any or all changes in power or load. So delicate is the action of the oil-cylinder, that if the discharge-pipe be opened wide to the air, and thus present no resistance, the main valve will barely open, and the motion will be at the rate for which the channel-cock was set; and if the discharge be suddenly, almost totally closed—thus applying the maximum resistance to the pump—the main valve will instantly give more port, and suiting itself to its new duty maintain the same piston motion as before.

The oil cylinder is shorter than its stroke, and just before the end of the stroke it moves the main valve in a positive manner, and closes the main exhaust, thus forming an absolute cushion for the main piston. When a stroke is complete the tappets open the small valve and allow steam to act on the other end of auxiliary-piston, and move the main valve for a new stroke, but in doing this the auxiliary-piston is retarded by the oil piston. During this retardation the main piston rests and allows the water valves to seat quietly and gently, thus avoiding the usual shock and jar incident to the reversal of the piston motion.

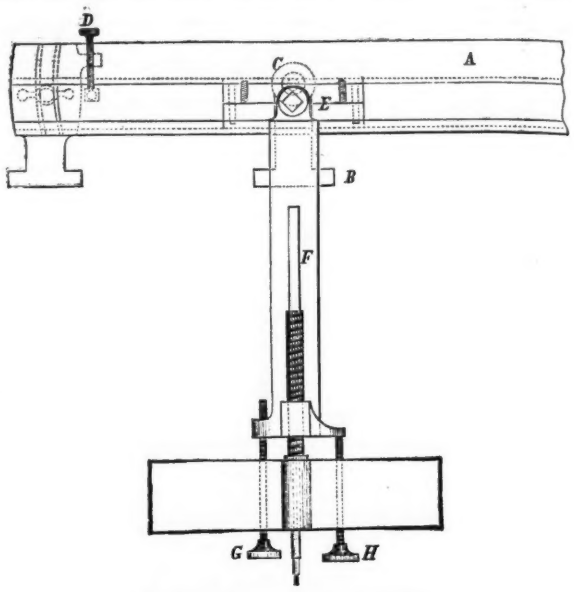
These pumping engines are built of every size, and adapted to every duty, by the Cope & Maxwell Manufacturing Co., of Hamilton, Ohio, and by their European colleagues, Hayward, Tyler & Co., of London.

Improved Gibbed Engine Lathe.

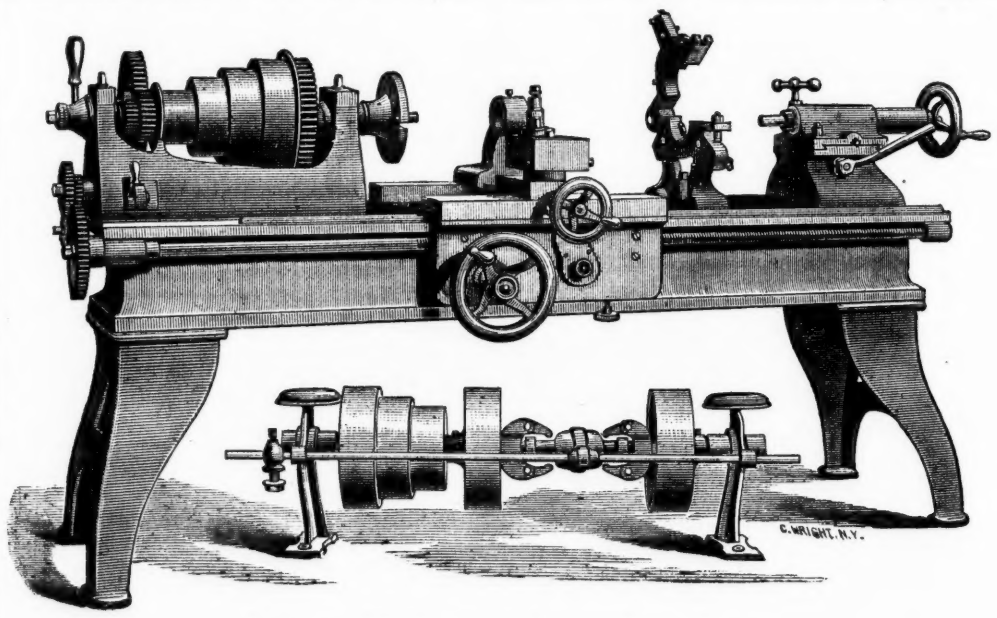
The new lathe here represented is well adapted to every kind of work for which the engine lathe is intended, and is claimed to be a very rigid, exact, and accurate tool. The carriage is gibbed its entire length on the outside of the bed, and is furnished with F A. Pratt's patent tool-post, by which the cutting-tool may be accurately adjusted, by raising or lowering, without being loosened in the post. The carriage is carefully fitted to the slides by scraping, and has an automatic cross-feed. Its spindles are steel, the live spindle having its front bearing 4¼ inches long by 2¼ inches diameter, the boxes being lined with genuine Babbitt-metal, and the lubricating cups constructed to entirely exclude all dust. The cone is turned inside and outside, perfectly balanced, and receives a belt 2½ inches wide, protected from the gears by guards on the head-stock. Foot-stock is secured in place by a cam-lever, and an improved spindle-clamp holds it rigidly. The leading screw conforms exactly to the United States standard, and, with the usual set of gears, screws from 2 to 32 threads to the inch can be cut. This lathe has independent worm and friction-feed, driven by gearing that can be instantly thrown out to allow the spindle to run free. All small reversing gears are of wrought iron. And all nuts, screws, and wrenches are case-hardened. The lathe swings 19 inches over the bed and 12 inches over the carriage.

A rear view of the lathe is introduced to show the attachment of Slate's patent device for turning tapers, which is further represented in the plan engraving. Objections to the usual way of turning tapers, by setting the dead spindle out of line, are these: It is difficult to turn perfectly round in this way; there is unequal wear on the center; several false cuts and repeated settings of the tail-stock are necessary to obtain the true taper; and every variation in the length of the work necessitates a re-setting of the dead spindle. These objections are obviated by this patent device. As will be seen by a glance at the rear view of the lathe, the taper attachment may be placed at any part of the bed. It is adapted not only to turning externally, but also to internal work chucked or secured to the face-plate, and does not interfere in the slightest degree with any other function of the lathe. It can be instantly put in operation, and adjusted, by a graduated scale, to the exact taper desired.

In the plan view of the taper attachment *A* represents an adjustable bar, supported on three brackets, *B*, on the back of the lathe-bed, the center one receiving the pivot, *C*, on which the bar, *A*, swings, the two other brackets supporting the bar and guiding it by radial slots in their upper surfaces Handle-nuts at each end, on the under side of the brackets, secure the bar in place. *D*



SLATE'S TAPER ATTACHMENT.



IMPROVED GIBBED ENGINE LATHE.—FRONT VIEW.

is a thumb-screw for accurately adjusting the bar. The slide, *E*, traverses a longitudinal slot in the bar, and to it is pivoted the nut-bar, *F*, which slides in a groove planed in the lower part of the tool-carriage. *G* is a stop-screw used in turning outside, and *H* is a similar screw for adjusting the tool for inside work. When the bar, *A*, is placed at an angle with the slides of the lathe-bed, it imparts a gradual transverse movement to the upper part of the tool-carriage toward or from the centers through the medium of the sliding nut-bar, thus giving the taper.

This lathe is manufactured by the Pratt & Whitney Co., Hartford, Conn.

Extracts From Chordal's Letters.

Mr. Editor:

* * * I failed to see you at the Master Mechanics Convention in Cincinnati for the simple reason that neither of us were there. I see by last month's paper that you have nominated me for "views" all the same. I not only failed to go to the convention, but I have not had time to read the reports. I am informed, however, that the standard axle question has been happily settled, and that the Master Car Builders' axle is now the standard sure enough. It was hard work though, for a great many didn't seem to think that a tolerable standard was better than no standard at all; and instead of the master mechanics falling in line with the master car builders and settling on something, they were reaching after impossible perfection. If they seek this, there never will be a standard at all, much less a correct one. Having adopted the standard axle, as suggested by the car builders, they will be able to concentrate their experience, and, in the course of years, can make a change for the better. As far as the delicate shades of difference which they discussed are concerned, I think a nickle tossed up could be made to decide the thing satisfactorily to all parties. The desire for a standard axle is not based on a desire for a better axle, but for a uniform one. It had better be uniformly bad than hap-hazardly good, for one may then know just what to expect and guard against it.

In support of my idea that a bad standard may be good I point to the standard gas and steam pipe which is at once perfectly ridiculous and ridiculously perfect. For instance, one-eighth inch pipe has a hole in it twenty-seven hundredths in diameter, and quarter inch pipe is over thirty-six one-hundredths bore. But it don't make any practical difference so long as we know it. Fifteen years ago it was the pride of an engine builder to put in heater pipes which no other shop could duplicate, and often he found he could not duplicate them himself. Only five or six years ago, I found a little engine with seven eighths inch heater pipes, and brass fittings cut fifteen threads to the inch. Thank the Lord there ain't fifty feet of seven-eighths pipe in the country now, and I hope there never will be.

Locomotive builders used to have a habit of using fancy sizes and pitches for their bolts, and it became necessary to have a set of taps in the shop for every engine on the road. Nowadays, the builders would be apt to hear from things of that kind.

* * * I see the rubber men have met unarmed, and resolved to advance prices of rubber goods.

This looks good, and the more the better. We have had enough of prices below cost. Like every one else in this world, I make my bread and butter out of the patronage of other men, and I won't give two cents for the custom of men doing business at a loss. When they raise on me I can raise also, and not till then. I don't see that it follows that there is no limit to the height to which prices should be raised. It would be very reasonable to put the price of pig iron twenty per cent. above cost, and it would be very unreasonable to inflate it to a hundred per cent. above. Notices of reductions in prices are bad things, and will not mix in the same mail with orders for work at paying prices.

* * * If a German in an American shop asks in German for an oil-can, he won't be apt to get it, and we can understand why; but if an Englishman asks in English shop lingo for a monkey-wrench, two things bother us, first, what he wants, and second, why he don't ask for what he wants, instead of talking about slide-spanners and screw-keys.

We would be bothered still more, and lose a little of our conceit if we were set down in Crewe or Manchester shops. There is really something comical in the difference in nomenclature in the two countries. With the English, our steady-rest is a catch-plate, and our follow-rest, a back-stay. Our engine lathe is their self-acting lathe. Wm. Sellers & Company have absorbed the words self-acting and back-stay into their work, but the words won't stick after machines are out of the shop. Our 24-inch swing-lathe is in mother English a 12-inch center-lathe.

This word "swing" is certainly wrong, as it is too suggestive of radius, while we apply it to diameter. Our belt is with them a strap; our shipper, a strap-shifting apparatus, and our counter-shaft, an overhead driving apparatus, and so on, forever.

Special trades in our own country vary about as much. Men brought up in railroad shops always call a shaper a compound plane, and engine-slides of any description, guide-bars. But the worst thing the railroad machinist is guilty of is bringing into shops such words as "six square nuts," "three square files," etc. He has often sent cubs running around among the round-house men after circular squares, and straight hooks, and wondered at the greenness of the boy in supposing for an instant that there are such things, when he himself daily uses such outrageous words as "bevel square," "four square file," etc.

We have in this country four names for a connecting-rod: main rod, connecting-rod, pitman, and rod. Eccentric-rods are after cam-rods; cross-heads, tee-heads; and safety-valve weights are often called Pees, from P= weight in the equations, I suppose. The crank pin with some becomes a wrist. Of course there is no bigotry in the use of any of these terms, unless they are unyieldingly adhered to in Rome.

Bigoted disbelief in the virtue of universal processes is another thing. He who was brought up to bore cylinders with many cutters, and many blocks of wood in the boring-head, is seldom open to conviction on the single-tool question. If used to polished cylinder surface, he sees no good in the coarse-feed-broad-tool plan. The same with planing and turning. The modern slow-motion, quick-feed, broad-tool idea gets no sympathy from the slow-feed man.

He who has always seen cylinders bored vertically can seldom be brought to believe that any cylinder is best bored horizontally.

I spent some years in the West, and noticed that both the shops and workmen were much

less tied by processive forms than in the East.

Most of the shops had poor plants, and every job called for expedients.

The highest class of workmen from well regulated Eastern shops were helpless in such places, while the native workman existed on exciting emergency. My own observation in these Western shops resulted in mingled wonder, admiration, and disgust.

It was west of the Mississippi that I first met Sackett and Wycoff, who have now returned to the East. They both started small shops in Missouri, in the same town, just as the war came on. They found they had made a mistake, so they returned before they had run a month. Siegel occupied the town, needed grape shot, and, finding a hundred St. Louis moulders in his command, he "pressed" the two foundries and set the men at work. The cupolas and moulding floors had been designed for heats of one ton, not a dozen flasks had been made, one hundred and twenty miles to a railroad, or river, and no pig-iron, or coal on hand. Candle and soap-boxes from the subsistence department were used for flasks; cook-stoves, flat-irons, and sash-weights impressed for scraps; and charcoal used for fuel. The moulders worked all over the buildings and yards, and the cupolas ran continuously. It took six men to carry up charcoal for each one. The result was tons and tons of grape-shot. Then came a battle, a defeat, and a retreat. The grape-shot had not been cleaned or broken from the gates, so they were all thrown into wells and covered up, to keep them from the enemy. The enemy, however, thought it cheaper to dig up these grape-shot than to make new ones. They were thus well-fixed for grape, but had no iron for horse-shoes, so they commenced on the saw-mills in thirty counties, and used up all wrought-iron parts on hundreds of engines. Connecting-rods, piston-rods, mainshafts, bolts, nuts, and cam-rods—all went to heel the rebellious army mule.

The war ended one day and Sackett and Wykoff went back and found their tools wrecked. They refitted and began to reap a rich harvest. All the aforesaid engines came in for repairs; one hundred dollars for a single cut through a cylinder, and other work in proportion. Their Lehigh coal cost eighty dollars a ton, for it had to be hauled over a hundred miles, but they got twelve and a half cents a pound for the heaviest castings. I need not say they made money, but the game was up when a railroad came and brought competition within reach. They wisely sold out and came East again.

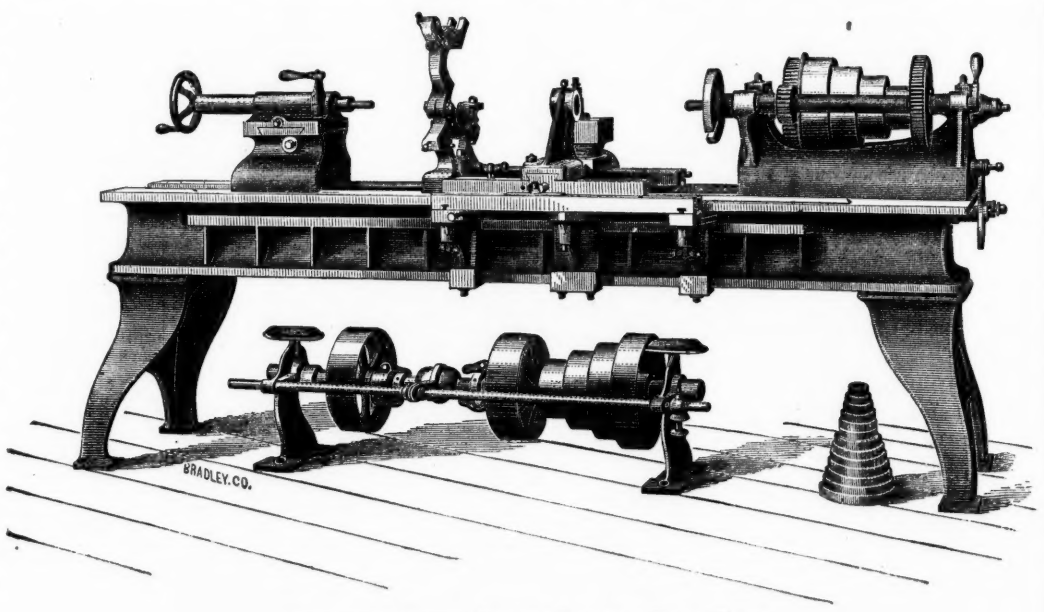
Among the saw mills in this region could be found many triumphs of unlettered genius. There were few real mechanics in these mills, shops hundreds of miles away by wagon road, and accidents always happening. The stop-valve on the engine gives out, but the mill must run while a new one is coming. A brake is put under the fly-wheel to slow the engine, and a stick of cord-wood thrown under the connecting rod stops it. Rod boxes and cross-head "brasses" of oak were common. A slide-valve of black-walnut was found once in a while. Oil gives out and water is used till a hog is killed. The saw gets sprung, and the factory wants thirty dollars to exercise the saw makers magic art upon it, and the mill would stand still three weeks. The backwoods sawyer straightens it in an hour, without knowing just how he did it. The cylinder gets cut, and the negro engineer bores it out with a grate-bar. *I saw him doing it.* Flange joints are made with white sand mixed with the white of an egg, and the main belt is spliced with bark. A boiler wanted new fire-box and tubes. The negro engineer undertook the job. He never saw the inside of a boiler shop, and never saw a piece of machinery outside that mill, but the owner had sent for iron, tubes, and rivets, and the man had gone to work in his own way. When I happened in that section, he was boring the tube sheets. His special tools were a four-by-four scantling and and a five-eighths bolt. All these mills have a ratchet drill. He laid off and drilled the center holes, put the bolt through the hole and scantling, drove a cutter through a mortise in the scantling, and using the scantling as a lever, walked round and cut the holes, feeding by driving on the cutter. I was interested enough to caliper some holes already done and found them as good as the ordinary boiler shop job. I am satisfied the fellow finished the thing up in good shape. An educated or skilled mechanic would never have attempted to do this work in the woods.

* * * Some men seem to be deficient entirely in power for devising make-shifts, or in adaptability to novel circumstances.

I was told of a well-educated engineer who found himself fifty miles from port with a broken vacuum gauge. He showed utter helplessness, and proposed immediate return. His assistant was a shovel engineer. He saw nothing amiss in a broken gauge, or in the absence of one. He traded places with his chief, and made the trip by sense of feeling. When his condenser felt too hot he gave her more injection.

We are told of a party of royal astronomers who went into the northern regions to make observations. The expedition was an important one, but the weather was so severe that the mercury forming the artificial horizon was frozen, thus rendering their instruments useless. They gave it up and came home without the idea of a lamp under the mercury having occurred to them.

CHORDAL.



IMPROVED GIBBED ENGINE LATHE.—BACK VIEW.

Steam Engineering.

BY CHAS. A. HAGUE.

Part I.

The observation and experience of the author of this article, has confirmed him in the opinion that there exists among so-called "practical men," a great need of "Scientific Education" on subjects directly pertaining to the business they may be engaged in.

The very foundation of science is the faculty of *calling things by their right names;* for, by such a method only, can one be perfectly understood and answered accordingly.

These lines are written in the exacting light of Webster's dictionary, and it is suggested to all who may read them with the view of knowing just what they mean, to read with a dictionary close at hand, and if its occasional use will *start* readers in a habit of thoroughly comprehending whatever they give their attention to, an important step towards a scientific education will have been taken.

Science is simply "a positive statement of truth, established by observation and experiments," and can as well be applied to the operations of every-day work, as to the most intricate branches of human inquiry; in other words, there is one *best way* to perform every operation in the different trades, varying, of course, with surrounding circumstances, and a comprehension of these best ways constitutes the science of the trade.

Art, on the other hand, is "the power of performing certain actions;" so it would seem then, for a man to be successful at his calling, he must acquire both science and art; or the knowledge of "how to do a thing," and the skill to "do it."

Some of the deductions in this article are based upon the theory of the "Mechanical Equivalent" of heat; a theory that has probably been established as firmly as any natural law, although some controversy was indulged in but a short time ago.

According to above theory, heat is simply "a mode of motion," that is an influence by which motion is produced among the atoms of substances; this *motion*, however, is imperceptible, the *heat* only being detected by the sense of feeling.

A comprehensive idea of heat would be, that it is a means employed by a *natural force* to produce motion; *why* the force should operate in the manner in which it does is beyond the bounds of the present writing; indeed the "physical constitution of heat" is one of the mysteries not yet solved by science

When a piece of iron is heated, then (scientifically speaking) the minute atoms of which it is composed are set in motion to a degree corresponding to the intensity of the force influencing them. If the motion is sufficiently increased, the iron passes from solid to liquid, or melts. The motion may be still further increased until the substance of the iron combines with oxygen of the air, combustion takes place, the heat is set free, the iron is destroyed and there remains gases and cinders.

For convenience of comparison and measurement heat is divided into "units," in the same manner that distance is divided into inches.

Careful experiments by different men and at different times, have resulted in standard of value for each unit of heat; this standard is "772 foot pounds," that is, the dynamic energy inherent in one unit of heat is equivalent to the dynamic energy required to lift 772 pounds one foot high, or one pound 772 feet high, friction not considered; this amount of work is considered to be the "mechanical equivalent" of one unit of heat.

Before proceeding further, a few definitions will be in order:

Force: Is any action that can be measured by weight alone.

Dynamics: Is a positive statement of truth, established by observation and experiment, in relation to forces in motion.

Dynamic energy: Is the mechanical power or work produced by forces in motion.

And now we come directly to our subject:

Steam engineering is a branch of the science and art of *developing dynamic energy from heat.*

The subject might be divided into several distinct branches, but the extent of this article is necessarily limited to a general treatment.

Heat having been produced by combustion of fuel, the first step is to provide some means for conveying it (heat) to where it can be placed under conditions favorable to the development of dynamic energy, or power.

The means employed in this case is water, and the instrument by which the power is made available for practical use is the Steam Engine; in these lines the well-known reciprocating engine, only, will be considered.

Water having absorbed heat, assumes the gaseous form, or becomes steam, and in this state acts as the vehicle by which the heat is transported from boiler to engine, but it must be borne in mind that it is not the steam, but *heat* that does the work.

Before proceeding further, it will be well to observe that "dry saturated steam," is steam in which just sufficient heat has been absorbed to evaporate all moisture; its temperature and density (quantity of water) are elements which bear a proportion to each other, corresponding to the pressure.

When an excess of heat has been absorbed, the steam is said to be "superheated," and when a deficiency of heat exists, the steam is termed "wet."

Steam parts with heat, to be converted into effect by the operation of EXPANSION, for if it (steam) were confined in a tight vessel and perfectly protected from loss of heat by radiation, and not allowed to expand, it would possess no other forces than that of its pressure on sides of vessel and its weight; its weight would of course be the weight of the water which, having absorbed heat, became steam.

Without regard to loss by friction, radiation, and conduction, the utmost quantity of steam that could be consumed in the production of a certain power, would be when no expansion took place within cylinder of engine; in which case the steam would exert only its "force of displacement."

For example: The pressure in boiler is 100 lbs. per inch: induction valves of engine are "set" to admit steam during whole stroke of piston; then steam will flow into cylinder in a manner similar to that of water entering a pump; that is, the heat being supplied by fire under boiler as fast as it passes into cylinder in the form of steam.

In above case the heat exerts only its *external* force, or that action measurable by weight alone, and it does so because heat generated in furnace of boiler, having free communication with cylinder through the medium of the steam, maintains the full pressure of 100 lbs. per inch throughout, and thus prevents expansion. The force of heat operating in this manner is similar to the force of so much weight acting through space.

An engine under such circumstances would be practically "pumping" the heat from the boiler, without utilizing any of its (heats) mechanical equivalent.

On the other hand, an extreme towards economy in use of steam would be, to admit the steam to cylinder at boiler pressure and then close induction valve at a point in the stroke, that would cause the steam to expand in a non-condensing engine, just down to pressure of atmosphere, and in a condensing engine down to pressure due to vacuum on exhaust side of piston.

Theoretically, and without regard to certain *counteracting effects*, that will be discussed further on, the greater the difference between pressure at point of cut-off, and pressure at end of stroke, the greater will be the quantity of heat converted into dynamic energy.

It is the province of the steam engineer to take into consideration, the action of *all* natural laws pertaining to his vocation, and arrange his ideas in such a manner that his theory of construction will be adjusted to meet the demands of *every* influence that is exerted during the operation of producing HEAT, and converting its forces into mechanical effect.

Chicago, June 9th, 1879.

N. B. Cushing, of Jersey City, N. J., is very busy filling a contract for a new pattern of portable engine designed for agricultural purposes.

Gleanings from the Foreign Press.

A NEW TEMPERING PROCESS.

The *English Mechanic* gives the following description of a newly patented process for tempering iron and steel, the invention of M. A. Seguin, of Paris:

"That gentleman tempers 'articles of metal' by immersing or dipping them when in a heated condition in certain liquids, either entirely or only at the part or parts subject to compression under the strain to which the article is destined to be exposed. The liquids employed are either sulphuric acid diluted with water, dilute hydro-chloric acid or turpentine mixed with say about from five to six times its volume of water. When sulphuric acid is employed, the piece of metal after having been heated to say a cherry-red heat in a re-heating furnace or forge fire, or otherwise, is immersed either wholly or partially in a mixture composed of sulphuric acid at about 66° Beaumé and water in equal volumes. The temperature of the bath should be maintained at say from 60° to 100° C.; but it has been found by experience that the temperature of the bath may be elevated to about 200° C. without producing its effect. When turpentine is employed, care should be taken to agitate the vessel containing it continually, in order to prevent the turpentine from floating on the surface of the water, and becoming ignited by contact with the heated metal. In all cases the metal is allowed to remain in the bath until the temperature of the part immersed is lowered to that of the liquid, after which it is plunged into cold water.

The process is applicable to pieces of metal of homogeneous composition, or to articles formed by welding together pieces of iron of different qualities; but, according to the patentee, it will be obvious that the beneficial results of this mode of tempering become more apparent when the process is applied to metal of superior quality, the process having the effect of increasing to a considerable extent the power of resistance of any article of iron to a tensile, transverse, or torsional strain, by the complete or partial immersion of such article in one of the liquids mentioned.

In the case of a piece of metal in the form of a hook, when it is required to increase its power of resistance to a tensile strain, the back of the hook only for say about one-third of its thickness is dipped in the bath. When the piece of metal is of rectangular section, supported at one end only, and carrying a load at the other end, or acting as a cantilever, the under portion only is immersed to the extent of say about one-third of the depth or thickness of the piece. In the case of a solid bar of prismatic section supported at each end, and loaded at the middle, the upper portion is to be immersed in the bath. Although in the examples specified, the process is applied to a portion only of the depth or mass of the article, it is obvious that the article may be entirely immersed in the liquid if found advantageous or desirable."

Defects in Building Engine Lathes.

Editor American Machinist:

I see that Mr. Lyne, in the May number of your paper, calls Lathe-builders' attention to a pretty common defect in the method of gibbing down the cross-slide; and I should like to point out another feature, in the same and similar slides, where it seems to me further improvement can be made.

It is the practice with a large majority of machine-tool builders to form the dove-tail slides with the corners perfectly sharp, and the undercut angles necessarily sharp also. These acute angles weaken the castings, are difficult to plane, and even more difficult to scrape—when the slides are scraped as they should be—and the sharp corners of the dove-tail are easily bruised or broken off; besides they are of no very great value when perfect. There is another reason why these sharp corners should be cut away, the same that holds good while the center-holes, in the ends of a piece to be turned, should be drilled deeper than the lathe-centers penetrate. The necessity for this is, as is well understood, that unless the center-holes are so drilled, the holes will wear larger without increasing in depth, and so become a loose fit. Just so with cross-slides; they wear so as to be loose up and down, when tight sideways.

When the corners are cut off, so as to leave a flat ⅛-in. broad, and the angles planed with a round-nosed tool of 1-16 in radius, as shown in Fig. 1, a better job in every way is produced.

By referring to Fig. 1, it will be noticed that the screw for lightening the "gib," is not placed as is usual; the point of the screw being on a line drawn from the center of the wearing surfaces at right angles to them.

There is another feature about slide-rests, that seems to me can be bettered; in nearly all of the lathes the cross-slide is only a short block, working on a dove-tail so long that it does not work off at either end. As a result, when the dove-tail becomes the least worn, the block is free or loose in the center, or tight at the ends, or both. By using a right and left hand screw in place of the single coarse thread-screw, usually employed, there is no difficulty in making the sliding-block or section as long as the cross-bar of the slide-rest. In this form, the slide is a uniform fit in all positions, or grows better, instead of worse, by use; and besides that, the surfaces are very much better protected from dirt and misuse.

The iron over the dove-tail need not be over ¼ or ⅜-in. thick, and so the reduction in the swing of the lathe over the rest will be very slight.

I have worked with both sorts of slides, and from that reason ought to be better able to judge than those who have not, and my notion is, that when the slides are of equal length they are just right, and when a short block is worked a hundred times along the center of a long slide, to every time it is worked once at the ends, it is just wrong.

Yours, etc.,

CORNELL UNIVERSITY JOHN E. SWEET.
MECHANICAL LABORATORY,
Ithaca, N. Y., *June* 3, 1879.

Engineering Popularized.

(No. VII.)

Mr. Editor:

I have read with much interest the review in the last AMERICAN MACHINIST upon some engineering questions by Mr. Williams, giving evidence of much practical thought. I am a little surprised that the reviewer should have overlooked, in one or two instances, the very meat of the nut he was endeavoring to crack; and I reply with much pleasure, since it is quite time to bring out with clearness the importance of the points neglected. The article in question being written with an evident spirit of candid discussion, it is quite worth while to examine the paragraphs in detail.

Mr. W. first takes issue on the subject of compression; holding that any cushion over the amount barely necessary to take up the lost motion in the various bearings is a loss; against which I advance the statement that, *totally irrespective* of the question of lost motion, any engine should in theory display a compression up to the initial pressure, and approximate very closely thereto in practice. The trouble is, Mr. W. has not gone far enough in assuming that the only office of cushion is to make an engine run quiet. Compression directly effects the following qualities: quiet running, power and economy; and Mr. W. is at some pains to prove that compression beyond the least admissable amount is detrimental to the *first two*—a position which we are all willing to admit at the outset. Its effect in *economy*, however, he completely ignores. We will examine it and find that it acts in a two-fold manner.

Let us keep clearly in view that the steam engine is strictly a *heat* engine, and that steam, so far from being distinctively the motor, only happens to be incidentally the most convenient medium through which *heat*

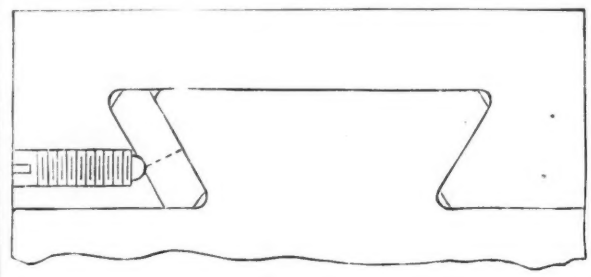


Fig. 1.

does its work. We have noticed, in a previous article, how from the instant of cut-off the temperature of the cylinder begins to fall, and this cooling process, if unchecked, continues until the instant of re-admission. Or, stated otherwise, the cylinder, after cut-off, is first cooled by the fall of temperature, corresponding to the fall of pressure and the evaporation of the spray already condensed, and on the return stroke, large quantities of heat are still further abstracted by the escaping exhaust, so that when the live steam is again admitted, it finds itself exposed to a large surface of metal at a temperature very much lower than its own. Condensation at once ensues until these surfaces are brought up to the temperature of the entering steam—the amount of this condensation increasing with every stroke up to a certain point in a very curious manner, as we may have occasion to see hereafter. It is now evident that we may close our exhaust at such a point before the completion of the stroke, as to imprison a certain quantity of exhaust steam, the latent heat in which is *squeezed out* as the compression increases, until at the moment of admission the surfaces are again raised to their normal temperature *entirely* by the heat thus *saved* from the exhaust steam. When we consider that in working steam at 80 lbs. and expanding down to atmosphere, the immediate surfaces of the cylinder are probably fluctuating at every stroke between the temperatures of 320 and 212 degrees, it will be seen that there is an immense aggregate amount of re-heating to be done, and all the heat to do it has got to come from somewhere, and that somewhere is the boiler, unless compression steps in and rescues it from the exhaust.

A consideration of the second effect of compression involves the question of clearance, and turns at once on the certainly very remarkable statement of Mr. W., that "neither does it matter how much, or how little (clearance) there may be." I had supposed the effects of clearance to be so thoroughly understood and admitted by engineers of all grades, that I had about decided to pass the question over entirely, lest these papers should become tediously long. It is high time to examine it, which we will do by considering exaggerated cases Fig. 1 is a diagram from the two ends of a cylinder, in which the right hand end A shows a clearance *a c* of 2 per cent., and the left hand end B, shows a′ c′, or 10 per cent. of the piston displacement:—steam 80 lbs., scale 40, cut-off ⅛th lb. Since *all* the steam in the cylinder after cut-off expands, our expansion curves must be run out from the clearance lines Oc, O′c′, as a base. Running out the curve in the manner already learned, card A shows a terminal at *t* of 20 lbs., and card B at *t′* of 26 lbs. To be sure, we have got a little extra work on account of the steam in the large clearance, because that end shows an m. e. p., *neglecting compression* of 40.8 lbs. against 35.6 lbs. m. e. p. on the other. Applying our rule for water consumption, card A shows 19.6 lbs. water for H. P. per hour, against 22 lbs. for card B—a difference of over 12 per cent. in favor of the smaller clearance—truly of some importance. Now, what will compression do for us, and how does it do it? Answering the second question first, we will note that, during exhaust the cylinder empties *entirely* down to steam at atmospheric pressure, and hence when the exhaust closes simultaneously with the opening of the lead, a certain number of cubic inches of waste space back of the piston have got to be filled with live steam before the initial pressure can be reached, under which the piston is supposed to move. Of course, the more the clearance the more the steam thus wasted. In a cylinder 16″ × 32″, with a clearance as shown in card B, 12.80 cub. in. of steam would be wasted, or very nearly wasted each revolution, or, in other words, two-thirds only of the steam actually used would do practically the same work if no clearance existed.

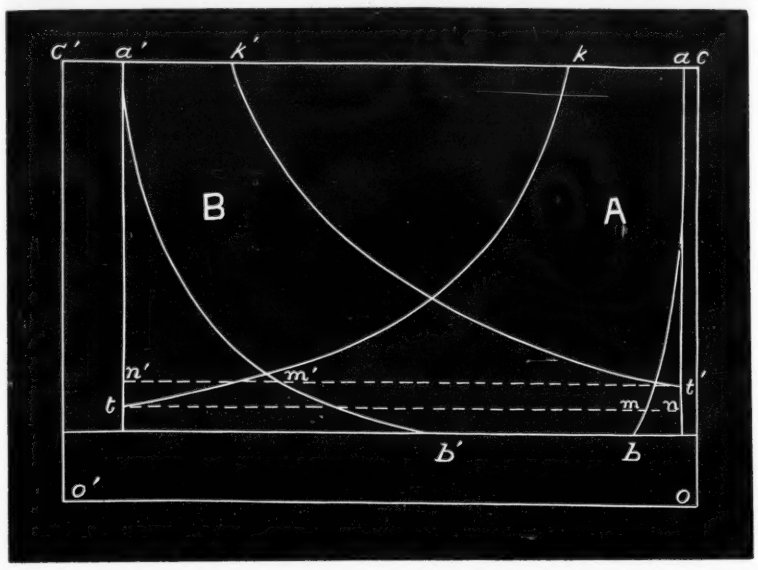
Now, the compression, that Mr. W. so much decries, gives us a partial remedy, in that it imprisons enough of the exhaust otherwise wasted, to just fill these waste spaces up to boiler pressure at the end of the stroke, so that when the steam is admitted it finds the clearances already full, and only the amount actually required for the work is expended. To illustrate:—lay down the initial compression curves *a b*, a′ b′ appropriate to each clearance, then re-calculating and correcting by the rules already given, our water consumption at once reduces on card A to 19 lbs. water, and on card B to 20.6 lbs. water. We have noted from the above that clearance, even when corrected by compression, is an evil invariably to be avoided.

Of course compression is a loss of power, but it is at the same time a gain of steam in a much greater proportion, and Mr. W. must not forget that his cushion is only a *spring*, which absorbs momentum from the fly-wheel it is true, but *returns* it all again with the strictest honesty as soon as the engine passes the center. Admit *absolute contact* in all the pin connections, or, as Mr. W. very neatly puts it, assume that the engine ends at the cross-head and compression is as valuable as ever. It is now obvious that "impression" by which Mr. W. simply means "lead" is no substitute for compression, since it disregards the vital idea of compression, viz.: *to save steam from the exhaust.* Nor is its effect on the quietness of the engine at all analogous to compression, since the latter acts as a perfect spring, taking up the lost motion *gradually*, while "lead" admits *full* pressure *instantly*, which is quite a different thing.

Mr. W. is eminently sound that no rule can be given to suit all engines in practice, but he must not be misled by the results from reducing compression in such individual cases as he cites, in which the necessity for forcing the pressure as stated to 100 and 110 lbs. in the boiler, affords the clue to the real source of loss, which is by no means chargeable to the compression considered by itself. That is to say, the actual result in coal and power in any given case, is the result of the joint and relative action of the whole plant, boiler as well as engine—while in the above discussion we have been considering a function of the engine alone, under assumed perfect conditions up to the throttle-valve. While I have met cases as cited by Mr. W., I suppose I could cite fifty others in my own practice where compression was productive of just as marked beneficial results. No engineer will permit himself to be misled by naked statements, or even the naked results of his own observation, and it is just such loose and hasty jumping at conclusions, without any discriminating analysis of cause and effect, which has done much, and will do much more to retard progress in engineering, as in other practical sciences. However, there are none of these questions which can be, or should be settled on paper; so that, although I believe the subject of compression to have been long ago settled in general practice, I propose shortly to conduct a careful series of experiments on the economic effects of compression under otherwise permanent conditions, the log and results of which I will with pleasure lay before your readers.

Mr. W. uses one-half a column to condemn the employment of algebraic formula in everyday engineering, in which he has my heartiest sympathy, with regrets that the offending $p \propto v^{-\frac{1}{0}}$, and accompanying exclamation (?) should have been taken so seriously. I fear that my mild attempt to be "sarcasmy" must have fallen very flat.

With regard to the diagram in March No. showing an efficiency of 78 per cent., if Mr. W. cares to look at it again, he will see that the excessive compression curve which he



thinks could not be obtained from that counter-pressure, is the one pertaining to the theoretical card shown for comparison. The actual compression line is the merely rounded corner which he will notice below, and I refer to it only because others may also have misunderstood the Figure.

His further remarks about the fallacy of expecting a steam line fully equal to boiler pressure, certainly could not have been called out by anything that I have written.

Such a result is undoubtedly physically impossible with any practicable construction of engine; an approximation within 2 lbs. being as close as may be expected under the most favorable conditions.

Mr. W. "infers" that the cards heretofore shown are from automatic engines—but don't know. If the cards in question had been original works of art, I might have been justified, as with certain other line drawings of earlier years, in affixing the legend: "This is a cow!" Being executed, however, by the indicator, I shall throw upon that instrument the responsibility of speaking for itself.

This article is now much too long to enter into a review of your other correspondents; and, in fact, I am compelled to admit, that after having devoted a good deal of the spare time of the past month to it, I am still at a loss for its drift and connection. Mr. Hague has worked very hard to make something very plain, and it is a matter of regret that the weakness of my own powers of comprehension—aggravated, possibly by the distressing absence of the minor parts of speech in the article in question—should prevent a suitable reply.

Both the gentlemen are disposed to question the possibility of the adiabatic curve in practice, and Mr. Hague in particular seems much worried that I should attempt to introduce any original improvements on the Mariotte curve. Let me at once waive all claim to originality in the matter, and refer him on that subject, as well as on some other points in thermo-dynamics, on which he seems a little mixed, to the leading scientific authorities of the last half century.

Lest I be misunderstood, however; in previous articles I have given the definition of the adiabatic curve, and described the conditions for its theoretical formation. I have also stated that it has been and can be formed in actual practice. Whether or not the adiabatic curve, *as* formed in actual performances, is formed *because* of the existence of those conditions, *i. e.* no transmission, or because of certain other conditions, which, while different, still happen to procure the same result, is a statement that I have not as yet made—and of that anon. The fact is, however, that it is quite possible to get the clean expansion, and the low terminal due to that curve in *some* way. I have any quantity of diagrams which show it, and I will be pleased to cite any skeptic to the engines from which they were taken, and he can verify them with his own instrument.

One word more: both my critics are very anxious that I should just mention what engine I got the cards from that I have presumed to criticise, but, Mr. Editor, I never shall tell.

WM. LEE CHURCH.

Use and Abuse of the Engine Lathe.

L. F. LYNE, M. E.

It is a remarkable fact, but nevertheless true, that the engine lathe, though a common tool, is very little understood by the class of men generally employed to run it. To prove this, it is only necessary to step into a railroad shop and watch the lathe hands for a short time.

The writer, not long since, dropped into a shop that has the reputation of doing first-class work, and, out of curiosity, observed the lathe hands at their work. One man was polishing a short piece of shafting. It was not of a uniform size throughout, for there was a journal on each end, besides different sizes where wheels were to be fitted. As the shaft revolved rapidly on the centers of the lathe, I noticed that none of these parts ran true with each other, and the question at once suggested itself—Why?

Simply because the man had neglected to ascertain whether or no the center ran true before commencing his work, and, upon taking the shaft out of the lathe and testing the center, it was found to run out of true about $\frac{1}{32}$d of an inch.

Another fact was demonstrated, that the shaft, while on the centers, would run true, or nearly so, one way, by reversing it was very much worse. This, too, was easily accounted for, simply by another examination of the centers, where we found that the angle of the two centers differed from each other by about five degrees, one being that much sharper that the other.

Hence, the reason for the shaft not running the same either way.

What I believe to be the best way to overcome these difficulties is a plan adopted by myself, while foreman in one of the leading railroad repair shops, i. e, to have a standard center-gauge for every lathe in the shop. The angle of the gauge adopted by me was 77 degrees, which was found to work better in general practice than the U. S. standard, which is 60 degrees, the latter being too sharp and more easily injured, particularly when turning a taper. Each lathe hand was put in possession of one of these gauges, and required to inspect the centers every day. Very soon the men got so much accustomed to this rule that it ceased to be any inconvenience.

Another point in favor of a shop standard is, that a piece of work can be changed from one lathe to another, and no doubt entertained as to its running true.

There are a great many different ways of applying the center to a lathe, but will only mention the most common. In this case the centers are turned tapering, and fitted to the holes in the spindles The part that projects beyond is left straight, and the ends pointed to suit the gauge.

A center designed in this manner, when forced into its place by the pressure which naturally comes upon it, by being pressed against the piece of work placed in the lathe, is usually removed (if it be the live center) by driving a taper pin into a hole through the spindle opposite the end of the center. The pressure upon the end of the center will force it out. On the other hand, if it be the dead center, and is not provided with a device like the one described, the screw which moves the spindle out and in is left long enough, so that when the spindle is drawn *in* its full length, the end of the screw will press the end of the center and force it out.

My experience with these and similar devices has been, that the pin which should be kept on the lathe for the purpose described is seldom or never found; and instead of running the spindle that holds the dead center back (sometimes six or eight inches), a hammer is more frequently used to remove the centers. I condemn this process for the reason that the constant repetition of it will enlarge the hole in the ends of the spindles, like a drift-pin used by boiler makers, so that the centers will not have a bearing for some distance inside the hole.

The plan of having a square upon each center as used by some tool makers, is far preferable to any other; for a wrench can be applied, and with a simple twist of the wrist the center is easily removed and the holes are not injured. The centers should never be struck with a hammer. A very common practice among lathe hands (and I regret to say first-class hands) is to place not only their tools, such as wrenches and hammers, but even their work indiscriminately upon the shears of the lathe. It is a well-known fact that the lightest blow given to the sharp corners or the scraped surface of the shears, will raise little obstructions and cause the carriage to scratch while passing over them. Dirt and grit will settle into these scratches, thereby rapidly destroying the utility of the machine to produce fine work.

In some shops it is a very common practice to heat bent shafting or bars of iron, hang them on the centers of the lathe, and use a bar to pry up the place at which the bend occurs, then apply smart blows on top with a heavy hammer to straighten the piece of work.

I remember a case where the spindle was bent and the lathe ruined by this process, and cannot use too strong terms in condemning it. But, says one, "We have a certain class of work (for instance, piston rods) which can be straightened quicker and more conveniently this way than any other." Very well; either have an old lathe to be kept for this kind of work in particular, or what is far better, put a pair of centers permanently in the blacksmith's shop and do all straightening where it should properly be done. A crooked bar should be straightened by pressure, as hammering simply stretches the skin of the iron; and this skin, when removed by the tool, allows the bar to incline towards its original shape. In no case should a heavy bar be straightened on the centers of the lathe in which it is to be turned. Some tool builders advocate the use of a narrow belt to drive a lathe and run it tight.

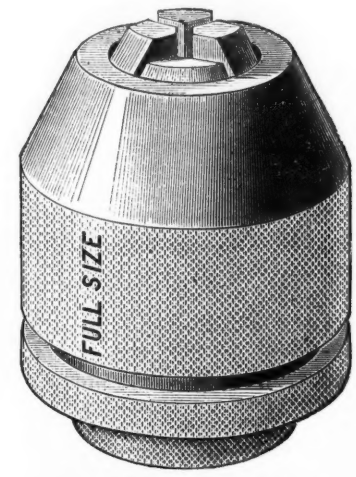
For instance, the writer had in his charge a 40-in. lathe, driven by a double belt 3-in. wide, and to get a reasonable amount of work out of that lathe, it was necessary to keep the belt very tight, so that the bearings were caused to heat and wear away very fast. The man running this lathe, (as is usually the case), was very negligent in keeping the belt up to the proper degree of tension, consequently there was a great loss from the necessity of taking light cuts in consequence of the slipping of the belt.

On the other hand, we had a 40-in. lathe driven by a belt 4-in. wide, which turned out as much again work, and the belt was not stretched to its utmost capacity.

The bearings ran perfectly cool, and with a great deal less wear.

All the parts of a lathe should be kept perfectly clean and thoroughly oiled, particularly the leading screw. Here is a point which should not be overlooked in selecting a lathe, to have all the parts easy of access and composed of few pieces.

Thus, having mentioned some of the abuses to which the lathe is subjected in ordinary practice, I hope that they will be carefully considered by the readers, and perhaps some of the remarks made herein may be applied. I here leave the subject until future opportunity shall permit me to discuss it still further.



The "Best" Drill Chuck.

The maker named this chuck the "best." One of the principal features of this new chuck is that it has two motions, one for the adjustment of the jaws and to perfectly center the dril without strain or wear on the chuck, so that the chuck will always be true. The other is one of the most powerful applications of power known, combining the screw and the wedge in such a manner as to hold the drill like a vise with the utmost ease. The two motions work harmoniously together, and make this, it is claimed, one of the most compact, durable and strongest holding chucks ever made. The accompanying cut shows a full size chuck that holds from nothing to three-eighths of an inch; it is all made from bar steel, and has a hole entirely through it. It is made to attach to a taper or a hollow spindle, and can be used for holding pieces to turn, and for any purpose within its capacity. This chuck will soon be for sale by all dealers in such goods at a price that will bring it within the reach of all. It is manufactured by A. F. Cushman, Hartford, Conn, who will give any further information required.

Master Mechanics Association.

In 1867 the Railroad Master Mechanics took a notion to unite in an association for the purpose of trading experience, and thus advancing usefulness as managers of the motive power of railroads. They formed a body and agreed to meet each year and bring with them in good shape some of their experiences upon matters previously named.

Each year they meet in some metropolitan city, and, in addition to discussing business, they have a good time generally. If there is anything to be seen they see it, and as they come in a large body and often bring the folks and some spending money, disinterested citizens who keep hotels and theaters and stores, and things generally, treat them well, and make things lively. Last year they met in Richmond, and this year their three days session was held at the Grand Hotel in Cincinnati. Instead of roving around each year, there was a question mooted this session of making Cincinnati a permanent place of meeting, on account of its central location and extraordinary facilities for reaching the hill-tops. The opening up of the question of a permanent place of meeting is a something they owe to every city they meet in and a debt easy to pay.

The plan of operations of the association is as follows: A subject being proposed, it is casually discussed and then turned over to a committee with instructions to report in a year. The committee then digest the subject and put the whole matter in the form of a series of questions which are printed and mailed to all master mechanics. The answers to these questions when received and collated form the basis of the committee's report. When the report is presented the subject is discussed on the evidence and on its merits, and if it is capable of reduction to a standard a resolution to that effect is passed. A half a dozen such subjects furnishes work for a session, and each year the association

publishes a report, in book form, of the entire proceedings.

There are now eleven of these reports issued, in uniform style, and containing, as they do, practical information not to be found elsewhere, should be in the library of every mechanic who wants to keep posted These reports are furnished gratis to members and to subscribers to the printing fund, and are sold to all creation at a dollar per volume.

The meeting of the association is the signal for a general congregation of folks who deal with railroads, and a committee is generally furnished for the exhibition of their goods. This room will be found filled with material and devices and drawings and samples and good natured men whom, only for the mercenary feature of the exhibition, one feels glad to get among.

At the Cincinnati meeting, Mr. Chapman, the President of the Association, delivered a neat opening address, in which he referred to the fundamental principle of the association as economy in the management of railroad motive power, and he hit the nail on the head by saying that perhaps economy could be as well attained by improving method as by reducing wages.

He referred to real economy as essential, and said Master Mechanics had excellent opportunities for doing good by educating their men in economical methods of living, and in the knowledge of the silver rule of living within their incomes. I think if Mr. Chapman had appointed a committee to pro vide a system of education in this direction, that he would find his committee asking for something easier.

He stated that economy had prudential limits beyond which we should not pass.

The Secretary's report was read; it exhibited prosperity, the association being shown to be a bond-holder to the extent of over four thousand dollars.

In regard to the next meeting, Cleveland was decided on as the place, and the second Tuesday of May 1880 as the time. Mr. Chapman, of the Cleveland & Pittsburgh Railroad, was elected President for the ensuing year; Mr. Wells, of the J. M. & I., First Vice-President; Mr. Saunders, of the Northern R. R. of N. J., Second Vice-President, and Mr. Setchel, of the Little Miami, Secretary. These officers are hard workers and have been identified with the association since its organization, Mr. Chapman being their second President and Mr. Setchel their first real Secretary.

The subjects before the Convention this year were:

Form and Material for Locomotive Wheels and axles.

Size of Axles.

Form and Material of Boilers.

Lubrication.

Patents.

LOCOMOTIVE WHEELS AND AXLES.

The committee on this subject adopted the inquiry system but got few replies. In regard to engine truck wheels, they heard from 350 steel-tired cast iron wheels, and 228 steel-faced cast iron wheels, also from some all steel wheels and cast iron wheels. Those reporting varied in opinion; one member thinking the steel-tired wheel should be rated as four to one of cast iron only, while another thinks the economic advantage lies with the cast-iron wheel. Opinions are divided as to form, some favoring spokes, others double plates; the spoke men urging increased convenience of inspection and oiling, and the plate men urging that spokes fan up the dust and cause the brasses to wear faster. Ten breakages; seven of cast iron, three steel-faced. In regard to drivers, four prefer hollow spokes, hub, and rim; one, solid spokes and rim; and two, hollow rim. Two use hollow and solid, and express no choice. Nine breakages; all hollow spokes.

I would like to know how the European railroad men would read this report—men who never saw a cast iron driver in their lives. I suppose they would say that none of them would do.

In regard to tender-wheels, the same diversity of opinion exists as regards truck-wheels, and in about the same direction and proportion. Mr. Richardson, of the Boston and Providence road, gave the committee some interesting figures in regard to sundry wheels. Four Bochum cast-steel wheels, heavy enough for three turnings, ran 142,260 miles without any turning; a pair of paper wheels on hard work, ran 126,000 miles and were in fair condition, while a pair of cast-iron wheels running with the paper wheels were worn-out in 91,000 miles. A pair of steel-faced wheels were condemned on 121,921 miles, and another pair after the first turning, were condemned on 47,000 miles. Another pair ran 129,587 miles, and were in good condition; and another pair were condemned on total runs of 113,118 miles. A pair on hard work made only 31,372 on first run, while another pair in truck made near 65,000 miles first run.

Engine builders seemed as divided as railroad men on the wheel question, but it is to be presumed they put in what is called for. When the wheel report came up for discussion Mr. Hayes, of the Illinois Central, expressed regret that the committee had not devised a system of mileage calculation by which some uniform results might be obtained. He also gave the results of his own calculation on comparative cost per mile of iron and paper wheels, and gave seven cents per thousand miles for chilled iron, and nine cents for paper.

He also stated that wheel makers were now selling wheels on their mileage. In discussing how mileage should be figured, Mr. Sprague suggested that the interest on the investment was an essential element.

SIZE OF STANDARD AXLE.

The committee on this subject made two reports; the majority recommending an axle a quarter of an inch smaller than car builders' standard, and the minority advising concurrence in car builders' standard. The answers to inquiries were as various as inches on a yard-stick, and the discussion following the report brought out advocates of every size After a warm discussion, the car builders' axle was adopted as the standard of the association. This axle is as follows: Total length, 6 ft. 11½ inches; journal 3¾ ×7 inches; wheel seat, 4⅞ inches.

DRIVER AND TENDER AXLES.

The report develops little that is new. Journal sizes of driver-axles run from 6½ by7, to 7 by 8. But few use steel. Most all use parallel axles, but one advised an enlarged center especially for rear axle. Six breakages reported, four of which were close to hub after ten years' work.

In truck axles, the report states that an enlargment of journals seems to be desired; they now run about 4½ by 7½. In tender axles the same appears to be the case, the journals being in this case below the car builders' standard. Mr. Hewett gave some figures on relative cost of two sizes, viz.: A 2,400 gallon tank, with car builders' axle, ran 73,650 miles, and cost for lubrication and waste $2.27, while a similar tank on 3¼ by 5½ journals ran 75,730 miles and cost $7.27.

BOILERS.

The boiler committee brought in an excellent report, which we intend publishing in full. The discussion following was confined mostly to the question of material, whether steel or iron, high steel or low steel.

LUBRICATION.

The report on oils was somewhat positive, and recommended strongly the use of mineral oils for general work, as being superior to all patent oils. The reports contain much of value, which we may give at length in future.

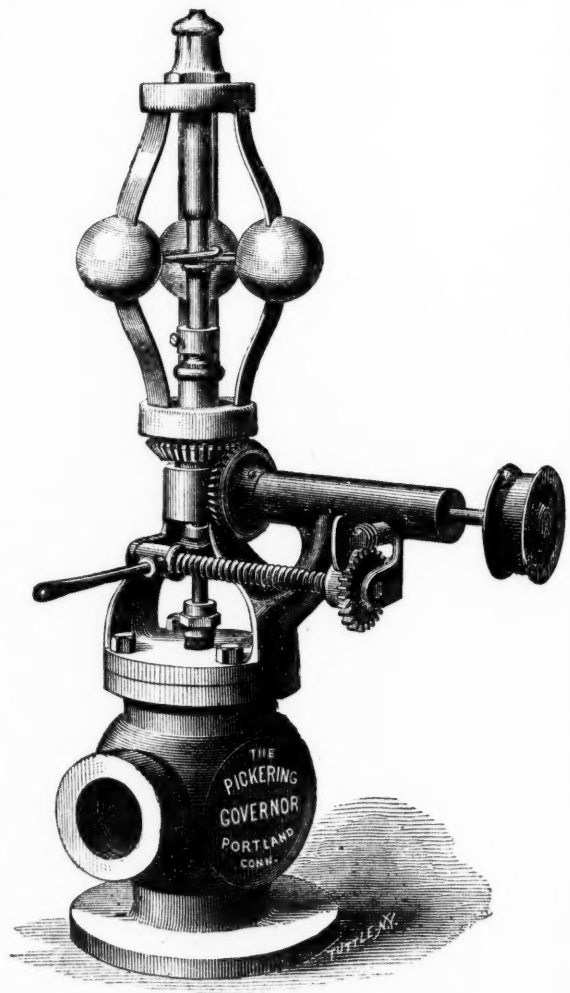
PATENTS.

Mr. Raymond advised action, looking to a judicious selection of patented devices which might be useful and valuable, as distinguished from those of trifling or no value. The immense number of patents on railway appliances—there being 2,000 on couplers alone, confuses and mortifies members and they never know what ground they stand on. He suggested some systematic plan of information for all concerned, by which the mechanical and legal status of an invention may be known.

The subjects for next meeting are to be: Boiler Improvements; subject continued. Comparative performance with regard to economy of operations. Smoke Prevention. Prevention of Noise of Safety Valves. Shop Plant.

The Pickering Spring Governor.

When it becomes necessary to obtain results by the aid of mechanical appliances, that device which is the most simple in construction, most direct in its application and action, and most durable and economical in effect is the most desirable one to secure.



THE PICKERING SPRING GOVERNOR.

The necessity for simplicity and direct action is nowhere more apparent than in the construction and application of the Governor to the steam engine; as, when, from usual or unusual causes, a variation is taking place in the amount of work being done, that Governor which will the soonest adjust the steam valve to the new requirement will certainly be the one to keep the engine more nearly uniform in speed; thus reducing the total amount of steam needed, requiring less fuel, and insuring economy.

It is claimed that the extreme sensitiveness of the "Pickering" Governor,—which we illustrate this week—with its great available centripetal force, cause it to fulfill the foregoing requirements. The reason of this is that the principles involved in its action are such that a mechanical movement is obtained without a joint, thus dispensing entirely with friction.

Another equally important arrangement is the combination of the balls and springs in such a manner that the comparatively slow movement produced by gravitation is entirely ignored, and in its stead the quick and sensitive action of simple, but finely-adjusted steel springs is obtained.

In order to fully appreciate this extreme sensitiveness, it is only necessary to attempt to maintain the tension of an ordinary "jig" saw by means of gravitation, say, a weight attached to a cord running over pulleys.

The law of gravitation is so completely ignored in the construction of this Governor, that it will work equally well in either a vertical, inclined, horizontal, or inverted position.

The required centripetal force being entirely due to the tension of the springs, the valve is not carried past the desired point by the momentum of heavy balls, as is the case when sudden variations take place in the amount of work being done by an engine supplied with the *old style* of Governor.

All parts are made interchangeable, so that in case of accident parts may be sent by mail or express, with a certainty of their being correct.

After years of experience with various kinds of valves, the "balanced puppet" style has again been adopted as that which insures the most perfect equilibrium under varying pressures. As this kind of valve does not enter the seats, the troublesome effect of "sticking"—caused by unequal expansion—is avoided; and the valves and seats being made of special steam-metal, corrosion is entirely obviated; as is also the cutting effect so generally complained of as being produced by the current of steam when iron valves and seats are used.

It is often found desirable to change the working speed of an engine, even while in motion. A lever with movable weight is still applied by some governor makers for increasing resistance to the centrifugal exertion of the revolving balls. Now, this weight being actuated solely by gravitation, is guilty of the same objectionable sluggishness of action with which the heavy balls are charged; in fact, an otherwise sensitive Governor would be injured by such a "hanger on."

In combination with the Pickering Governor, the tension of a spiral spring is utilized for varying the resistance to the centrifugal force of the balls; the tension being adjusted by means of a worm and worm-wheel, which may be manipulated *while the engine is in motion*, thus adjusting the speed according to the requirements.

The application of a simple device for detaching the valve from the Governor, and allowing it to close so as to stop the engine in case the Governor belt breaks, is an additional feature of security where an engine is in charge of a person careless enough to allow the belt to get out of order. As the driving-belt holds up by means of an idler-pulley—the tripping device—it cannot act except the belt breaks. This arrangement is very effective, but unnecessary where ordinary attention is given to the care of belts; a good belt well-cared for will not break, and if flanged pulleys are used, the belt will not run off.

Previous to the recent improvements, this Governor was well known among engineers in this country and in Europe, and we are informed is now making more friends than ever. Its introduction abroad is largely due to its exhibition at International Exhibitions. Specimens of it are to be found at most of the technical institutes of Europe, and the International Juries at Paris, 1867; Vienna, 1873; Philadelphia, 1876, and again at Paris last year, awarded this Governor well-deserved recognition. Large numbers are in use in Great Britain; the well-known engineering firm, Joseph Evans & Sons, of Wolverhampton, being the agents. It is manufactured at Portland, Connecticut, by T. R. Pickering & Co.

A workingmen's club and institute has been formed at Boston as a memorial of the late Rev Dr. E. M. P. Wells. Rooms are being fitted up, a library and gymnasium will be added in time, and during the winter months there will be lectures and entertainments of various kinds for the benefit of members. Unsectarian religious services will be held every Sunday, and a guarantee fund from which workingmen can borrow to help them in building homes will be established, with a system of life insurance.

Steam Engine Cut-Offs.

BY STEPHEN ROPER, ENGINEER.

If the pressure against the piston, and the load or resistance on an engine, were always uniform, it would be an easy matter, by making a cylinder of the proper dimensions, to set the cut off at a point to allow of perfect expansion ; as, however, the load and pressure are constantly varying, it is necessary to reduce the consumption of steam to a minimum, which, by its perfect expansion, will give the required power. To these considerations may be attributed the efforts which have resulted in the adoption of three devices, now in general use, for working steam expansively, viz., the *positive, adjustable, and variable,* or automatic cut-offs.

In the positive cut-off, the expansion of the steam is effected by what is known as a lap on the valve by which the steam is cut off at the same point in each stroke, independent of load or pressure, although in some instances expansion is effected by an independent cut-off riding on the back of the main valve, and receiving its motion from an extra eccentric, which is termed the riding cut-off. Such an arrangement, like the for mer, though productive of beneficial results, is, nevertheless, very defective, inasmuch as it is stationary and cannot be varied to suit the requirements of work, pressure and speed. In the "adjustable" cut-off, the expansion in the cylinder is effected by an independent valve, which can be adjusted by the engineer, outside of the steam-chest, by means of a screw, hand-wheel, or other mechanical arrangement, to meet the requirements of work and pressure. The link in its application to the steam engine belongs to this class of cut-offs. Although such arrangements are adjustable, they are not self-adjusting, and when once set will cut off independent of circumstances.

The variable, or automatic cut-off, performs its functions according to circum. stances of load and pressure, both in admitting and cutting off the steam. It gives regularity of motion, and secures all the benefits of expansion, as the governor operates the mechanism, which determines the exact point in the stroke where the supply of steam from the boiler should be cut off and expansion begin. This insures the most perfect regulation under the most varying circumstances, as the slighest change in the position of the governor will increase or decrease the initial charge of steam admitted, thus balancing any variation in the amount of resistance. The regulation of the flow of the steam to and from the cylinder automatically is based on the right principle. As the pressure of steam is always calculated in pounds per square inch above atmospheric pressure, the nearer the indicated line of expansion approaches that of the atmosphere, the greater is the actual power derived from the utilized volume of steam.

Adjustable cut-offs were used in England at a very early date in the history of the steam engine, but no notice of a variable automatic cut-off ever appeared, so far as the writer is aware, until 1827, when Tred gold suggested "that a regulation might be effected, by adjusting the steam valves so that they may be closed at an earlier or later period of the stroke, according as the engine may have more or less work upon it." He referred to an experimental attempt to accomplish this purpose, made by Mr. Field, with a little portable engine, exhibited in a drawing, with its previous throttle-valve still in place.

In an elaborate treatise on steam engines, published by Galloway & Herbert, in the year 1834, special reference is made to the engine described by Mr. Tredgold, with this comment: "We have never seen Field's regulating valves practically applied." In the second edition of Tredgold's treatise, republished in 1838, is reproduced the same engraving, with this additional notice: "The regulation of steam engines, by more or less expansion, is confined chiefly to regulating by hand." In 1835, Whitelaw and Roberts made an attempt to dispense with the use of the throttle-valve, and in the same year Doctor Lardner, in a treatise on the steam engine, hailed with much enthusiasm the advent of an improvement in the manner of working steam expansively, which dispensed with the use of the throttle-valve.

The automatic cut-off is now generally admitted to be one of the most important and valuable improvements ever made to the steam engine, and, as might have been expected, there are several claimants for the honor of its invention, among whom are Zachariah Allen, of Providence, R. I., Geo. H Corliss, Frederick Sickles, and Wm. Wright, of Newburg, N. Y. The weight of the evidence is on the side of Zachariah Allen, as the date of his patent is December 24, 1833 ; and his claim for the first practical application of an automatic or variable cut-off to the steam engine, for regulating the speed and the flow of steam to the cylinder, was in 1834. Mr Corliss claims to have practically applied an automatic cut-off to the steam engine in 1848 ; his patent dates March 10, 1849. Frederick E. Sickles' patent for an automatic releasing valve gear, for steam engines, dates May 20, 1842.

Now, Mr. Editor, it is not the intention of the writer of this article to attempt to establish priority of invention for any of the parties named in the foregoing article, but rather to give them an opportunity to come out and establish their claim, as whoever the party may be that invented and first practically applied the automatic cut-off to the steam engine deserves his full meed of honor. Let us hear from Messrs. Allen, Corliss, Sickles, Wright, and others on the subject.

WILLIAM SELLERS, OF PHILADELPHIA.

Our American Mechanical Engineers.

No. I.

WILLIAM SELLERS.

The history of the mechanical progress and triumphs of a nation might be epitomized in the lives of a few of its representative engineers. In a country like ours, where most of the largest and best known establishments of productive industry have been built up by the men who now own and conduct them, we have no need to search the records of a past generation to trace the handiwork of existing masterpieces of mechanical genius that challenge the admiration of artisans in every part of the civilized globe. In designing and building tools for working iron and metals—machine tools and their appurtenances—no other country, during the last quarter of a century, has kept pace with our own. Without effort to detract credit from those to whom it justly belongs, we can safely say that in the advance of this great industry no other name is so widely and so favorably known as that of William Sellers, of Philadelphia, whose portrait we present upon this page. The subject of our sketch was born some fifty-three years ago in a suburb of the Quaker City, upon a very old homestead which is still in possession of the family. After completing such an education as was generally afforded the youth of his time, he learned the trade of a machinist in the old shops of J. Morton Poole, on the Brandywine, at Wilmington, Del. Among his shopmates were Barton Hoopes, of the present firm of Hoopes & Townsend ; James Moore, proprietor of the Bush Hill Iron Works and Samuel Tatum of Cincinnati. After completing his term of apprenticeship in the shops where he began (which is not always the fashion at this day), he came to Philadelphia and in 1848, in connection with his uncle, Edward Bancroft, established the manufacture of machine tools, shafting and gearing, under the firm name of Bancroft & Sellers from which the present house of Wm. Sellers & Co. had its origin. They determined to make a class of tools both durable and efficient and capable of performing the most work with the least skill on the part of the workmen. Many innovations were made upon the common style of tools and workmanship which caused some close struggles with ignorance and prejudice, but which by 1853 had gained for them such a patronage that they found it necessary to enlarge their facilities, which was done by erecting new buildings occupying an entire square, bounded by Sixteenth and Seventeenth Streets, Pennsylvania Ave. and Hamilton St. The shops were built upon original and improved plans with special reference to convenience in handling work, one feature being the extension of tracks from the Reading Railroad into all parts of the works. In all these arrangements the genius and forethought of Mr. Sellers were prominently exhibited. The new system of this establishment and the perfection of its outfit attracted the attention of engineers from all parts of the world.

In 1855, Mr. Bancroft, the senior partner died, and the business passed into the hands of two brothers, William Sellers and John Sellers, Jr., they adopting the firm name of William Sellers & Co. The only change in the firm since that date was in 1873, when three new members, who had long been employed in the establishment, were admitted. Since 1855, William Sellers has been the active and responsible head of the house, himself originating nearly all the improved machines and tools brought out at these works. Besides their regular business of machine tool-making, they have for many years made other things needed in the equipment of railroads, such, for instance, as turn-tables for locomotives, sliding or transfer tables and turn-tables for pivot bridges. Their turntable has been adopted on almost all railroads in North and South America and some have been sent to Europe. When the injector for supplying steam boilers with water, as arranged by M. Giffard, of France, was brought to the notice of engineers in this country, Mr. Sellers was the first to substantially recognize its value, and his house became the licensees of the invention and worked it during the continuance of the patent.

In France, after years of trial, no essential change was made in the instrument. In America, extended experiments resulted in improvements by Mr. Sellers, constituting inventions of nearly equal importance with the original. Recognizing these improvements, the French Government made an order for drawings of injectors after the American model for use in the French marine service.

The limits of our space forbid any detailed reference to the many excellent improvements in machine tools carried out by Wm. Sellers & Co. In 1862, Mr. Sellers invented and introduced an iron planer which made a radical departure from all others then in use. This machine involved a new principle operating the table. A shaft crossing the bed diagonally has on it a spiral pinion; this spiral pinion engages the teeth of a straight rack and imparts an exceedingly uniform motion to the table with less friction than the old style then in use. The greater part of the driving gear is placed outside the bed, within easy reach of the workman's hand. This planer is now built in England and other countries of Europe under royalty to the inventor. Mr. Sellers originated in 1864 a new system of screw threads and nuts, better adapted to the machine practice of this country than the Whitworth system. In April of that year, he, in explanation, read an essay on the subject before the Franklin Institute, a committee of which reported fully in favor of its general adoption. For some years it was known as the "Sellers System," but was afterward adopted by the United States Government, and is now the recognized U. S. Standard. In 1870 it was found necessary to still further enlarge the works which was done by the purchase of a square of ground north of them. Upon this lot extensive foundries were erected with unusual facilities for the production of fine castings of large size. The space now occupied by the works is about five acres. They have exhibited at several universal exhibitions always with the most gratifying success. The award at Vienna was to "Sellers—for pre-eminent achievements in the invention and construction of machine tools, many of which have been adopted as patterns by the constructors of tools in all countries." Mr. Sellers was on the original committee of the Franklin Institute which suggested the memorializing of Congress to hold the Centennial Exhibition, and was appointed one of the first Vice Presidents of the Board of Finance. He took an active part in making the Exhibition a success, and his house made the largest display of machine tools ever shown by a single establishment at an exhibition.

Besides attending to his extensive duties as head of this large machine tool establishment, he, in 1869, in association with his brother, founded the Edge Moor Iron Works, near Wilmington, Del., where the longest and the highest double track railroad bridges in the world have been built. These shops show the stamp of his remarkable ability in the novelty and greatly improved character of the machinery for manufacturing bridge work. Mr. Sellers is also President of the Midvale Steel Works, located at Nicetown, in the city of Philadelphia.

In person, Mr. Sellers is affable and pleasant, easily approachable and always open to sound reasoning. He is remarkably clear-headed, comprehending any ordinary subject at a glance. He combines both the qualities of inventive and executive business ability in a high degree. As a worker, he is indefatigable, devoting his entire energies to the accomplishment of any object that he sets out to attain He is a diligent student of mechanics and metallurgy. In conclusion, we cannot pass over the fact that personally Mr Sellers is well known to be of an unassuming disposition, not courting individual public attention, this being, as far as we can learn, the first sketch of his career that has appeared in print.

publishes a report, in book form, of the entire proceedings.

There are now eleven of these reports issued, in uniform style, and containing, as they do, practical information not to be found elsewhere, should be in the library of every mechanic who wants to keep posted These reports are furnished gratis to members and to subscribers to the printing fund, and are sold to all creation at a dollar per volume.

The meeting of the association is the signal for a general congregation of folks who deal with railroads, and a committee is generally furnished for the exhibition of their goods. This room will be found filled with material and devices and drawings and samples and good natured men whom, only for the mercenary feature of the exhibition, one feels glad to get among.

At the Cincinnati meeting, Mr. Chapman, the President of the Association, delivered a neat opening address, in which he referred to the fundamental principle of the association as economy in the management of railroad motive power, and he hit the nail on the head by saying that perhaps economy could be as well attained by improving method as by reducing wages.

He referred to real economy as essential, and said Master Mechanics had excellent opportunities for doing good by educating their men in economical methods of living, and in the knowledge of the silver rule of living within their incomes. I think if Mr. Chapman had appointed a committee to pro vide a system of education in this direction, that he would find his committee asking for something easier.

He stated that economy had prudential limits beyond which we should not pass.

The Secretary's report was read; it exhibited prosperity, the association being shown to be a bond-holder to the extent of over four thousand dollars.

In regard to the next meeting, Cleveland was decided on as the place, and the second Tuesday of May 1880 as the time. Mr. Chapman, of the Cleveland & Pittsburgh Railroad, was elected President for the ensuing year; Mr. Wells, of the J. M. & I., First Vice-President; Mr. Saunders, of the Northern R. R. of N. J., Second Vice-President, and Mr. Setchel, of the Little Miami, Secretary. These officers are hard workers and have been identified with the association since its organization, Mr. Chapman being their second President and Mr. Setchel their first real Secretary.

The subjects before the Convention this year were:

Form and Material for Locomotive Wheels and axles.

Size of Axles.

Form and Material of Boilers.

Lubrication.

Patents.

LOCOMOTIVE WHEELS AND AXLES.

The committee on this subject adopted the inquiry system but got few replies. In regard to engine truck wheels, they heard from 350 steel-tired cast iron wheels, and 238 steel-faced cast iron wheels, also from some all steel wheels and cast iron wheels. Those reporting varied in opinion; one member thinking the steel-tired wheel should be rated as four to one of cast iron only, while another thinks the economic advantage lies with the cast-iron wheel. Opinions are divided as to form, some favoring spokes, others double plates; the spoke men urging increased convenience of inspection and oiling, and the plate men urging that spokes fan up the dust and cause the brasses to wear faster. Ten breakages; seven of cast iron, three steel-faced. In regard to drivers, four prefer hollow spokes, hub, and rim; one, solid spokes and rim; and two, hollow rim. Two use hollow and solid, and express no choice. Nine breakages; all hollow spokes.

I would like to know how the European railroad men would read this report—men who never saw a cast iron driver in their lives. I suppose they would say that none of them would do.

In regard to tender-wheels, the same diversity of opinion exists as regards truck-wheels, and in about the same direction and proportion. Mr. Richardson, of the Boston and Providence road, gave the committee some interesting figures in regard to sundry wheels. Four Bochum cast-steel wheels, heavy enough for three turnings, ran 142,260 miles without any turning; a pair of paper wheels on hard work, ran 126,000 miles and were in fair condition, while a pair of cast-iron wheels running with the paper wheels were worn-out in 91,000 miles. A pair of steel-faced wheels were condemned on 121,921 miles, and another pair after the first turning, were condemned on 47,000 miles. Another pair ran 129,587 miles, and were in good condition; and another pair were condemned on total runs of 113,118 miles. A pair on hard work made only 31,372 on first run, while another pair in truck made near 65,000 miles first run.

Engine builders seemed as divided as railroad men on the wheel question, but it is to be presumed they put in what is called for. When the wheel report came up for discussion Mr. Hayes, of the Illinois Central, expressed regret that the committee had not devised a system of mileage calculation by which some uniform results might be obtained. He also gave the results of his own calculation on comparative cost per mile of iron and paper wheels, and gave seven cents per thousand miles for chilled iron, and nine cents for paper.

He also stated that wheel makers were now selling wheels on their mileage. In discussing how mileage should be figured, Mr. Sprague suggested that the interest on the investment was an essential element.

SIZE OF STANDARD AXLE.

The committee on this subject made two reports; the majority recommending an axle a quarter of an inch smaller than car builders' standard, and the minority advising concurrence in car builders' standard. The answers to inquiries were as various as inches on a yard-stick, and the discussion following the report brought out advocates of every size After a warm discussion, the car builders' axle was adopted as the standard of the association. This axle is as follows: Total length, 6 ft. 11½ inches; journal 3¾ ×7 inches; wheel seat, 4⅞ inches.

DRIVER AND TENDER AXLES.

The report develops little that is new. Journal sizes of driver-axles run from 6½ by7, to 7 by 8. But few use steel. Most all use parallel axles, but one advised an enlarged center especially for rear axle. Six breakages reported, four of which were close to hub after ten years' work.

In truck axles, the report states that an enlargment of journals seems to be desired; they now run about 4½ by 7½. In tender axles the same appears to be the case, the journals being in this case below the car builders' standard. Mr. Hewett gave some figures on relative cost of two sizes, viz.: A 2,400 gallon tank, with car builders' axle, ran 73,650 miles, and cost for lubrication and waste $2.27, while a similar tank on 3¼ by 5½ journals ran 75,730 miles and cost $7.27.

BOILERS.

The boiler committee brought in an excellent report, which we intend publishing in full. The discussion following was confined mostly to the question of material, whether steel or iron, high steel or low steel.

LUBRICATION.

The report on oils was somewhat positive, and recommended strongly the use of mineral oils for general work, as being superior to all patent oils. The reports contain much of value, which we may give at length in future.

PATENTS.

Mr. Raymond advised action, looking to a judicious selection of patented devices which might be useful and valuable, as distinguished from those of trifling or no value. The immense number of patents on railway appliances—there being 2,000 on couplers alone, confuses and mortifies members and they never know what ground they stand on. He suggested some systematic plan of information for all concerned, by which the mechanical and legal status of an invention may be known.

The subjects for next meeting are to be: Boiler Improvements; subject continued. Comparative performance with regard to economy of operations. Smoke Prevention. Prevention of Noise of Safety Valves. Shop Plant.

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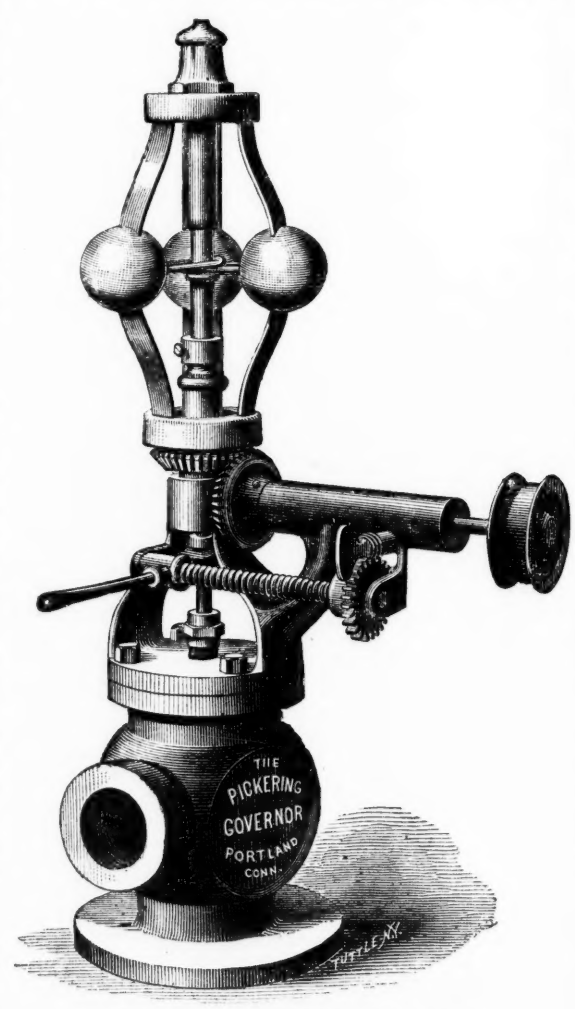

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Adjustable cut-offs were used in England at a very early date in the history of the steam engine, but no notice of a variable automatic cut-off ever appeared, so far as the writer is aware, until 1827, when Tredgold suggested "that a regulation might be effected, by adjusting the steam valves so that they may be closed at an earlier or later period of the stroke, according as the engine may have more or less work upon it." He referred to an experimental attempt to accomplish this purpose, made by Mr. Field, with a little portable engine, exhibited in a drawing, with its previous throttle-valve still in place.

In an elaborate treatise on steam engines, published by Galloway & Herbert, in the year 1834, special reference is made to the engine described by Mr. Tredgold, with this comment: "We have never seen Field's regulating valves practically applied." In the second edition of Tredgold's treatise, republished in 1838, is reproduced the same engraving, with this additional notice: "The regulation of steam engines, by more or less expansion, is confined chiefly to regulating by hand." In 1835, Whitelaw and Roberts made an attempt to dispense with the use of the throttle-valve, and in the same year Doctor Lardner, in a treatise on the steam engine, hailed with much enthusiasm the advent of an improvement in the manner of working steam expansively, which dispensed with the use of the throttle-valve.

The automatic cut-off is now generally admitted to be one of the most important and valuable improvements ever made to the steam engine, and, as might have been expected, there are several claimants for the honor of its invention, among whom are Zachariah Allen, of Providence, R. I., Geo. H. Corliss, Frederick Sickles, and Wm. Wright, of Newburg, N. Y. The weight of the evidence is on the side of Zachariah Allen, as the date of his patent is December 24, 1833; and his claim for the first practical application of an automatic or variable cut-off to the steam engine, for regulating the speed and the flow of steam to the cylinder, was in 1834. Mr. Corliss claims to have practically applied an automatic cut-off to the steam engine in 1848; his patent dates March 10, 1849. Frederick E. Sickles' patent for an automatic releasing valve gear, for steam engines, dates May 20, 1842.

Now, Mr. Editor, it is not the intention of the writer of this article to attempt to establish priority of invention for any of the parties named in the foregoing article, but rather to give them an opportunity to come out and establish their claim, as whoever the party may be that invented and first practically applied the automatic cut-off to the steam engine deserves his full meed of honor. Let us hear from Messrs. Allen, Corliss, Sickles, Wright, and others on the subject.

WILLIAM SELLERS, OF PHILADELPHIA.

Our American Mechanical Engineers.

No. I.

WILLIAM SELLERS.

The history of the mechanical progress and triumphs of a nation might be epitomized in the lives of a few of its representative engineers. In a country like ours, where most of the largest and best known establishments of productive industry have been built up by the men who now own and conduct them, we have no need to search the records of a past generation to trace the handiwork of existing masterpieces of mechanical genius that challenge the admiration of artisans in every part of the civilized globe. In designing and building tools for working iron and metals—machine tools and their appurtenances—no other country, during the last quarter of a century, has kept pace with our own. Without effort to detract credit from those to whom it justly belongs, we can safely say that in the advance of this great industry no other name is so widely and so favorably known as that of William Sellers, of Philadelphia, whose portrait we present upon this page. The subject of our sketch was born some fifty-three years ago in a suburb of the Quaker City, upon a very old homestead which is still in possession of the family. After completing such an education as was generally afforded the youth of his time, he learned the trade of a machinist in the old shops of J. Morton Poole, on the Brandywine, at Wilmington, Del. Among his shopmates were Barton Hoopes, of the present firm of Hoopes & Townsend; James Moore, proprietor of the Bush Hill Iron Works and Samuel Tatum of Cincinnati. After completing his term of apprenticeship in the shops where he began (which is not always the fashion at this day), he came to Philadelphia and in 1848, in connection with his uncle, Edward Bancroft, established the manufacture of machine tools, shafting and gearing, under the firm name of Bancroft & Sellers from which the present house of Wm. Sellers & Co. had its origin. They determined to make a class of tools both durable and efficient and capable of performing the most work with the least skill on the part of the workmen. Many innovations were made upon the common style of tools and workmanship which caused some close struggles with ignorance and prejudice, but which by 1853 had gained for them such a patronage that they found it necessary to enlarge their facilities, which was done by erecting new buildings occupying an entire square, bounded by Sixteenth and Seventeenth Streets, Pennsylvania Ave. and Hamilton St. The shops were built upon original and improved plans with special reference to convenience in handling work, one feature being the extension of tracks from the Reading Railroad into all parts of the works. In all these arrangements the genius and forethought of Mr. Sellers were prominently exhibited. The new system of this establishment and the perfection of its outfit attracted the attention of engineers from all parts of the world.

In 1855, Mr. Bancroft, the senior partner died, and the business passed into the hands of two brothers, William Sellers and John Sellers, Jr., they adopting the firm name of William Sellers & Co. The only change in the firm since that date was in 1873, when three new members, who had long been employed in the establishment, were admitted. Since 1855, William Sellers has been the active and responsible head of the house, himself originating nearly all the improved machines and tools brought out at these works. Besides their regular business of machine tool-making, they have for many years made other things needed in the equipment of railroads, such, for instance, as turn-tables for locomotives, sliding or transfer tables and turn-tables for pivot bridges. Their turn-table has been adopted on almost all railroads in North and South America and some have been sent to Europe. When the injector for supplying steam boilers with water, as arranged by M. Giffard, of France, was brought to the notice of engineers in this country, Mr. Sellers was the first to substantially recognize its value, and his house became the licensees of the invention and worked it during the continuance of the patent.

In France, after years of trial, no essential change was made in the instrument. In America, extended experiments resulted in improvements by Mr. Sellers, constituting inventions of nearly equal importance with the original. Recognizing these improvements, the French Government made an order for drawings of injectors after the American model for use in the French marine service.

The limits of our space forbid any detailed reference to the many excellent improvements in machine tools carried out by Wm. Sellers & Co. In 1862, Mr. Sellers invented and introduced an iron planer which made a radical departure from all others then in use. This machine involved a new principle operating the table. A shaft crossing the bed diagonally has on it a spiral pinion; this spiral pinion engages the teeth of a straight rack and imparts an exceedingly uniform motion to the table with less friction than the old style then in use. The greater part of the driving gear is placed outside the bed, within easy reach of the workman's hand. This planer is now built in England and other countries of Europe under royalty to the inventor. Mr. Sellers originated in 1864 a new system of screw threads and nuts, better adapted to the machine practice of this country than the Whitworth system. In April of that year, he, in explanation, read an essay on the subject before the Franklin Institute, a committee of which reported fully in favor of its general adoption. For some years it was known as the "Sellers System," but was afterward adopted by the United States Government, and is now the recognized U. S. Standard. In 1870 it was found necessary to still further enlarge the works which was done by the purchase of a square of ground north of them. Upon this lot extensive foundries were erected with unusual facilities for the production of fine castings of large size. The space now occupied by the works is about five acres. They have exhibited at several universal exhibitions always with the most gratifying success. The award at Vienna was to "Sellers—for pre-eminent achievements in the invention and construction of machine tools, many of which have been adopted as patterns by the constructors of tools in all countries." Mr. Sellers was on the original committee of the Franklin Institute which suggested the memorializing of Congress to hold the Centennial Exhibition, and was appointed one of the first Vice Presidents of the Board of Finance. He took an active part in making the Exhibition a success, and his house made the largest display of machine tools ever shown by a single establishment at an exhibition.

Besides attending to his extensive duties as head of this large machine tool establishment, he, in 1869, in association with his brother, founded the Edge Moor Iron Works, near Wilmington, Del., where the longest and the highest double track railroad bridges in the world have been built. These shops show the stamp of his remarkable ability in the novelty and greatly improved character of the machinery for manufacturing bridge work. Mr. Sellers is also President of the Midvale Steel Works, located at Nicetown, in the city of Philadelphia.

In person, Mr. Sellers is affable and pleasant, easily approachable and always open to sound reasoning. He is remarkably clear-headed, comprehending any ordinary subject at a glance. He combines both the qualities of inventive and executive business ability in a high degree. As a worker, he is indefatigable, devoting his entire energies to the accomplishment of any object that he sets out to attain. He is a diligent student of mechanics and metallurgy. In conclusion, we cannot pass over the fact that personally Mr. Sellers is well known to be of an unassuming disposition, not courting individual public attention, this being, as far as we can learn, the first sketch of his career that has appeared in print.

AMERICAN MACHINIST

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☞ *We are not engaged in procuring patent rights, or in selling machinery; nor have we any pet scheme to advance, or hobby to ride.*

☞ *We invite correspondence from practical machinists, engineers, inventors, draughtsmen, and all those specially interested in the occupations we represent, on subjects pertaining to machinery.*

NEW YORK, JUNE 28, 1879.

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We begin in this number a series of biographical sketches, with portraits, of our American mechanical engineers, which will be read with pleasure by all those directly interested in machinery. It is our aim to present facts without exaggeration, and to do this we shall avail ourselves of the best sources of information.

Our Change to a Weekly.

With the present number the AMERICAN MACHINIST changes from a monthly to a regular weekly publication, and will hereafter appear fifty-two times a year, instead of twelve times. This important change—one not anticipated at the outset twenty months ago—has been thrust upon us, in a great measure unsought, by the constantly increasing pressure upon our columns of original articles, correspondence, reviews of new machinery, and varied mechanical information, which it has been utterly impossible to publish in the limits of our space as a monthly; also by the urgent solicitations of our readers in every part of the Union, as set forth in commendatory and encouraging letters constantly being received at this office. It has always been our aim to benefit and please our rapidly growing circle of patrons, therefore, as the only complaint expressed is that their favorite mechanical newspaper reaches them at too long intervals, we have found it necessary to make a new departure and issue every week. In taking this step we determined to improve the widely (and substantially) recognized value of the AMERICAN MACHINIST by engaging additional talent and introducing some new features which will at once commend themselves to practical and progressive artisans.

Referring back to the introductory to our first issue (November, 1877,) we said: "With the best facilities at our command we propose to make this the standard machinery newspaper of America, and to this end shall direct all our efforts, being convinced that the same editoral and business corps can not manage with the highest success two or more technical journals of the same class."

Readers of the AMERICAN MACHINIST today will bear witness that our undertaking, as outlined in the above quotation, has been crowned with signal success. Our subscribers are numbered in every one of the thirty-eight States of the Union, in the British North American Provinces, Mexico, the West Indies, and the various countries of South America and Europe. A glance over our advertising columns will show those acquainted with the great machinery industries of this country that we exhibit therein a good representation of the leading establishments that have made America the most advanced and most rapidly progressing country for machinery in the world. We make this reference with just pride, though it is the *first time since our initial number that we have published a single word in our reading columns directing attention to our advertisements.*

To more effectually carry out our plans for improvement, we have incorporated the AMERICAN MACHINIST PUBLISHING CO., with a capital of $50,000, and in so doing have effectively increased our active editorial and business corps. The management, however, of both the editorial and business departments will remain unchanged. The same independent stand adopted upon the first issue will be rigidly maintained. *We have never asked nor received one cent for anything published in the reading columns of the* AMERICAN MACHINIST. Our readers may be assured that they are not perusing paid notices, published under the guise of editorials. We are under no special obligations to railroad or steamboat companies, never having asked nor accepted free passes from any of them. One standing feature of this journal is the publishing of the number of copies printed each issue at the head of the editorial page. We hold that there should be no mystery about the exact circulation of any newspaper that solicits advertising patronage. The question about *character* of circulation can safely be left to an impartial jury of its readers.

The change from monthly to weekly necessitates an advance in subscription price from $1 to $3 a year. Recognizing, however, that there are thousands of practical mechanics upon whose well-earned wages three dollars for a subscription would make a serious inroad, we have arranged to have the MACHINIST sold regularly at *six cents a copy* by newsdealers, thus placing it within reach of almost every workman. Thanking our friends for their cordial support in establishing a representative machinery journal, with our greatly enlarged facilities we feel confident of meriting a continuance of their favors.

Engineers Societies of New York and Brooklyn.

The formation of Societies among individuals of a particular trade or profession has in view two widely different objects; first, the establishment of "trades unions," for the purpose of commanding certain uniform rates of wages, without regard to grade of skill or ability of its various members, and, second, the holding of meetings for mutual benefit and improvement in the occupations they follow. It was with the latter of these objects in view that a number of the practical steam engineers of New York city joined themselves together in March, 1868, and secured the incorporation of an association known as the New York Engineers Protective Society. Their objects, as set forth in their charter, are, "to protect the best interests of *bona fide* engineers; to grant mutual benefit and assistance to the members in case of sickness, accident, or distress; to aid and assist the living and bury the dead, and to elevate its members to a higher and better standard in the profession as engineers." In their preamble they say: "This society discountenances strikes *in toto*, believing that labor, like every other commodity, is governed by the demand and supply in the market, and it is left to the individual to decide for what price he will dispose of his skilled labor, and to whom, and this right of a member shall not be questioned." Organized upon this sound basis, the society has existed in an active and healthy condition ever since its formation, and now numbers sixty members. Their example has been followed by the Brotherhood of Stationary Engineers (in 1877) which has 150 members, and by the New York Society of American Artisans, both in this city, also by the Engineers' Protective and Benevolent Society of Brooklyn, which has 100 members. Members of each of these societies pay, every man, fifty cents a month in dues, and, in case of sickness, receives five dollars a week from the funds in the treasury, and, in case of death, seventy-five dollars is paid for funeral expenses. The members help each other to obtain situations and a fine is imposed for not reporting a vacancy or where a situation may be obtained for one of the society out of employment. The societies hold either weekly or semi-monthly meetings, at which time discussions are conducted upon such questions of emergency or expediency, as are brought up for debate. In these discussions a free use is made of the blackboard, and much valuable information is elicited, which becomes of mutual value to all the members. The disputants are selected on both sides, and when these have offered their arguments the question is opened to free debate.

It is estimated that there are about six thousand engineers in these two cities, a large part of whom are incompetent, yet are employed in responsible positions. It is a wonder that so few boiler expsosions occur. One object of these societies is to protect the interests of competent engineers, and to stop all persons who are not qualified from working at the trade. With this end in view, they certainly should receive the encouragement of the press and the public Especially every user of steam power should lend his aid to accomplish so good a result as the weeding out of incompetent and irresponsible managers of engines and steam boilers. The principle danger that these societies need to guard against is the admission of unworthy members. They cannot be too cautious in this respect. With right management, engineers societies on the plan of those here mentioned, will prove of great benefit to to the trade and to any community where many boilers are in use.

The Machine Tool Industry.

Machine tool-making as a distinct branch of industry is of recent date. A few years ago builders of steam engines and other kinds of machinery were accustomed to make for themselves such machine tools as they required. Special tools for special work were usually rudely-designed and imperfect affairs. Tool making was then considered subordinate to other more important operations—to the work made for sale. Our engineering practice of to-day would be impossible without the improved modern machine tools, the perfection of which underlies the perfection of their own and all other machine making. Machine tool-making has come to be established as a distinct and important branch of industry, and the best talent is devoted to designing and construct ng new tools for special purposes as well as in perfecting standard tools for more general use. To properly carry on a general machine tool establishment requires not only the highest mechanical talent, but a very long purse. New tools must be brought out from time to time requiring new sets of expensive patterns and perhaps costly experiments before they are made to work satisfactorily. This industry has suffered most severely by the depression in business, but is now gradually recovering a healthy condition. Many firms have been driven to seek other business, and some who have kept on have shrunk up in volume considerably. We have taken great pains to make out a complete list of machine-tool builders which is given below. We have endeavored to embrace all those who have been in business within the past ten years. The names of those who are now building machine tools are in capitals, the others in Roman letters.

MACHINE TOOL BUILDERS.

DAVID W. POND, Worcester, Mass.
P. BLAISDELL & Co. " "
LATHE & MORSE TOOL Co. " "
C. WHITCOMB & Co. " "
E. N. BOYNTON, " "
A. F. PRENTICE & Co. " "
WM. H. EDDY, " "
WORCESTER FREE INSTITUTE OF INDUSTRIAL SCIENCE, Worcester, Mass.
N. SAWYER & SON, " "
J. S. Wheeler & Co. " "
L. W. Pond, " "
Wood & Light Machine Company, " "
H. C. Pease & Co. " "
John Williams, " "
PUTNAM MACHINE Co., Fitchburg, Mass.
FITCHBURG MACHINE WORKS, Fitchburg, Mass.
New England Machine Co., Fitchburg, Mass.
BRAINARD MILLING MACHINE Co., Boston' Mass.
Shawmut Lathe Co., Boston, Mass.
Lowell Machine Shop, Lowell, Mass.
GEO. W. FIFIELD, " "
Benjamin Lawrence, " "
Ames Manf'g. Co., Chicopee, "
D. L. Harris & Co., Springfield, "
Wm. M. Hawes & Co., Fall River, "
FLATHER & Co., Nashua, N. H.
Warner, Whitney & Co. " "
J. F. C. Rider, South Newmarket, " "
JONES & LAMSON MACHINE Co., Windsor, Vt.

BROWN & SHARPE MF'G. Co., Providence, R. I.
STAR TOOL Co., Providence, R. I.
THE PRATT & WHITNEY Co., Hartford, Conn.
Geo. S. Lincoln & Co., Hartford, Conn.
NEW HAVEN M'F'G. Co., New Haven, "
McLagon & Smith " "
R. A. Belden & Co. " "
Chelsea Machine Co., Norwich, Conn.
HENDEY MACHINE Co., Wolcottville, "
WILLIAM GLEASON, Rochester, N. Y.
F. P. MICHEL, " "
Howard Iron Works, Buffalo, "
PROF. JOHN E. SWEET, Ithica, "
E. E. GARVIN & Co. "
FREELAND TOOL WORKS, "
Smith & Garvin, Bricksburg, N. J.
HEWES & PHILLIPS, Newark, "
WATTS, CAMBELL & Co. " "
Bolen, Crane & Co. " "
E. GOULD & EBERHARDT, " "
N. Y. Steam Engine Co., Passaic, N. J.
WM. SELLERS & Co., Philadelphia, Pa.
WM. B. BEMENT & SON. " "
FERRIS & MILES MACHINE WORKS, Philadelphia, Pa.
ED. HARRINGTON & SON, Philadelphia, Pa.
THORNE, DE HAVEN & Co. " "
ISRAEL H JOHNSON, JR. & Co. " "
C. Van Haagen & Co. " "
HARRISBURG FOUNDRY AND MACH. Co., Harrisburg, Pa.
BETTS MACHINE Co., Wilmington, Del.
HILLES & JONES, " "
NILES TOOL WORKS, Hamilton, O.
McFARLAN & NOTTINGHAM, Cincinnati, "
H. BICKFORD, " "
H. L. SHEPARD & Co. " "
BUCKEYE IRON & BRASS WORKS, Dayton, "
NEWTON & COX, Cleveland, "
L. D. Crane, " "
Bass Foundry & Mach. Works, Ft. Wayne, Ind.
Atlas Works, Indianapolis, Ind.

BRASS FINISHERS TOOL BUILDERS.

AMERICAN TOOL AND MACHINE Co., Boston, Mass.
COOPER, JONES & CADBURY, Philadelpbia, Pa.
Exeter Machine Works, Boston, Mass.
A. F. PRENTICE & Co., Worcester, "

We extend a cordial invitation to machinists, engineers and all parties specially interested in machinery and supplies, to call upon us whenever they visit New York. Our new office is in the center of the business portion of the city—96 Fulton St., corner of William, two blocks from Broadway—and is well supplied with directories, maps, atlases, guides, time tables and the like which are accessible to our visiting friends; also stationery and full facilities for correspondence. We take pleasure at all times in imparting such information as we possess that our visitors may desire.

Machine Shop Wages.

One of the gratifying signs of the times is that wages of machinists and other skilled mechanics have an upward tendency. Instead of reductions, advances are to be looked for, and altogether the prospects are encouraging for good workmen. We give below the rates paid in a few shops, and will continue in our next.

Juan G. Ribon, Jersey City, pays machinists $2.50 to $2.75 per day; blacksmiths the same.

N. B. Cushing, Jersey City, pays machinists $2 to $4 per day; blacksmiths $2.50 to $2.75.

D. L. & W. R. R., pays machinists $1.80 to $2.40 per day; blacksmiths $1.75 to $2.30; boiler makers $1.60 to $2.25; coppersmiths $1.60 to $2.

N.Y.C. & H.R.R R., also N.Y. & H.R.R., pay machinists 10½ cts. to 21¼ cts. per hour; blacksmiths 10½ cts. to 25 cts.; boiler makers 10½ cts. to 21 cts.

N. Y. Elevated R. R., pays machinists $2 to $3 per day; blacksmiths $2.25 to $3; boiler makers $2 to $2.25; coppersmiths $2 to $2.25.

PATERSON, N. J.

Danforth Locomotive and Machine Co., Paterson, New Jersey, employ 460 men, and pay machinists 15 cts. to 18 cts. per hour; blacksmiths 15½ cts. to 20 cts.; boiler makers (riveters) 15 cts.; (heaters) 10 cts.; drillers 11 cts. to 12 cts.; moulders 16 cts. to 17 cts.

Grant Locomotive Works employ 500 men, and pay machinists $1.60 to $1.80 per day; blacksmiths $1.80 to $2; boiler makers $1.80 to $2; moulders $1.80 to $2.

Passaic Rolling Mill Co., employ 600 men, and pay machinists $1.50 to $2.50 per day; others same as Danforth Locomotive Works. Men in the rolling mill are paid by the turn rates, making from $2 to $5 per day, (skilled hands).

Union Bolt Works, employ 120 men, and pay machinists $1.50 to $2 per day; blacksmiths $1.50 to $2.25; helpers $1.10 to $1.25.

Benjamin Eastwood employs 22 men, and pays machinists $1.50 to $2 per day; carpenters same; helpers $1 to $1.35.

Watson Machine Co., pay machinists $1.50 to $2.25 per day; blacksmiths $1.75 to $2.

J. Nussey & Co., employ 25 men, and pay machinists $1.75 to $2; blacksmiths $2; pattern makers $3; moulders $1.75 to $2.50.

The Hendey Machine Co., Wolcottville, Conn., pay machinists $1.75 to 3.00 per day, with an average of $2.25.

The Stiles and Parker Press Co., Middletown, Conn., pay machinists $2.00 to $3.00 a day; blacksmiths $2.00 to $3.50, and pattern makers $2.00 to $2.50.

The two zinc works at La Salle, Ill., voluntarily raised the wages of their 750 workmen twenty per cent., making an increase of $7,000 to $8,000 a month. The Companies say they can afford it.

At Massilon, O., the average pay of machinists is $11.50 a week; pattern makers $15.00; blacksmiths $9.60; helpers $7.50; bolt cutters $6.00; ordinary laborers $6.

Steel for Taps and Dies.

Why should American Machine Shops continue to import foreign steel for Tap and Die work, when American steel of equally good, or even better quality can be had for the purpose? Experimental tests have, from time to time, come to our knowledge, which have induced several of the largest American shops to wholly discard the standard brands of foreign steel heretofore demanded for this work, and to adopt American brands in their stead, with the very best results. With these firms this is no longer an experimental matter, twelve to eighteen months daily use and observation having effectually settled the question in favor of the native product.

We know of one instance in particular, where the workmen in a tap and die factory were so strongly prejudiced in favor of foreign steel that every American brand was invariably condemned before trial. They had been using a certain English brand. An American brand was finally "smuggled" in by the superintendent for a trial. After a few days use the workmen declared that the last lot of ——steel was the best they had ever had. From that time, this establishment discarded foreign steel.

We trust that more of our manufacturers in all lines of business will see the importance of *helping each other* in this kind of pioneer work, even at the cost of some inconvenience in the start, as every initial step in the substitution of American for foreign productions is a decided gain all round the line of American trades and industries.

To workmen especially, we would say: All of you who desire to hasten the day of better wages, and general prosperity, should remember that nothing will so effectually operate to unlock the wheels of plenty, as a wholesale abandonment of iron clad prejudices of the kind above illustrated, and a general desire to "make room for your Uncle" Samuel's products and handiwork.

PASSAIC, N. J., May 24, 1879.

Editors American Machinist:

In your excellent number for this month, I notice an article by Mr. W. J. Williams, of Philadelphia, on Mr. Church's "Engineering Popularized." In these days of high piston speeds, I think all engineers will admit that liberal compression must play a very important part in the successful working of our modern steam engines. Not only does compression serve us well in preventing shocks at the centers, by taking up the momentum of the reciprocating parts, and, at the same time, filling all clearances with steam near the initial pressure, but when the steam engine is considered as a heat engine there is another point gained, not only in theory, but actual practice and tests, and that is *the raising of the temperature of the cylinder-ends by compression.* I think our friend Mr. Williams has overlooked this one point in his article, and I believe he will agree with me in saying there is great economy in piston speed at say six hundred feet, over the old three hundred and fifty feet per minute. The initial pressure at the high speed can be held within five pounds of boiler pressure, if the sizes of steam *pipes* and *ports* are properly proportioned, remembering, at the same time, that the liberal sized ports are filled by compression at the beginning of the stroke, thereby saving live steam at this point.

W. H. HOFFMAN.

We have received an illustrated circular of an "improved boiler," constructed on the principle of a base-burning-stove. There are several testimonials appended from users of the boiler, but upon looking them over, we find that every one is dated April 1st, 1879. Now, the boiler may be all right, but so many steam users have been fooled by purchasing boilers upon written recommendations, that the date looks suspicious. No, gentlemen, chronicle your patent boiler literature the 4th of July or Decoration Day if you want us to stand in awe and admiration of your inventive genius, but send your All Fools Day circulars to the other paper across the way.

Business Specials.

Thirty cents a line for each insertion under this head.

For Screw Cutting Engine Lathes of 14, 15, 18, and 22in. Swing. Address Star Tool Co., Providence, R. I.

The Pratt & Whitney Co., of Hartford, Conn., make a specialty of Cutters for the teeth of gear wheels, that are shaped entirely by machinery and will make interchangeable all gears that are cut with cutters of the same pitch.

JUST PUBLISHED.—A Complete History of the Steam Engine, 450 pages, 163 illustrations, and 15 portraits. Price by mail $2.50. Send for circular. Frederick Keppy, Scientific Book Publisher, Bridgeport, Conn.

Those wishing special tools designed and built should write to W. H. Warren, 25 Hermon Street, Worcester, Mass.

The Huntoon Steam Governor Co., of Lawrence, Mass., warrant a direct saving in steam of from 10 to 20 per cent. over any other Governor known; while for quick and accurate regulation, great durability and lasting economy in use, they guarantee results never before attained by any other. See advertisement.

Brown & Sharpe M'f'g Co., Providence, R. I., keep in stock at reduced prices Patent Cutters for the teeth of gears which can be sharpened by grinding without changing their form. All wheels of same pitch cut with them will run together correctly. Send for new catalogue.

National Steam Pump, simple, reliable and durable. Send for illustrated catalogue with reduced price list. W. E. Kelly, New Brunswick, N. J.

Questions and Answers,

Under this head we propose to answer questions sent us, pertaining to our specialty, correctly and according to common sense methods.

(1) L. C. B., New Haven, Conn, writes: Will you please inform me, through the columns of your paper, in relation to the properties, use, etc., of Chrome Steel? A. This metal is a mild kind of steel, possessing better qualities than the best iron, and is free from the brittleness of cast steel. It is not only one-third stronger than any other steel but can be produced at a small cost, from the fact that when worn out, as in a steel-headed rail, it has a market value, as it can be made over again, which is not the case with Bessemer or any other cast steel. It will also weld without borax or flux, and when burnt can be redeemed on the next heat.

(2) J. R., Detroit, Mich., asks: Will you please furnish me with some process by which I can remove tin from copper, either pipes or sheets? A. Immerse the articles in a solution of blue vitriol.

(3) G. M. Y., Troy, N. Y., inquires: Is coal injured by allowing it to lie in a damp place or where the weather can act upon it? A. It has been found by recent experiments on this subject that the loss in weight, due to a slow oxidation and to the disengagement of gases which form the richest part of bituminous coal, may equal one-third of the original weight. The heating power in such coal was lowered to 47 per cent. of its former capacity. The same coal exposed to the air, but in a closed receptacle, did not lose more than 25 per cent. of gas and 10 per cent. of heating power. Bituminous coals alter most rapidly. This shows the disadvantage of damp cellars, and of leaving coal uncovered for long periods and subject to bad weather.

(4) A. C. D., Rochester, N. Y., writes: I am a stationary engineer and have great trouble with leaky rubber joints in the steam pipes about my engine. Can you inform me of a medicine by which I can overcome this evil? A. Procure some round copper wire, anneal and make a ring of the proper size to fit the joint. Taper the ends so as to make a lap joint, and sweat together, using soft solder; or, if the heat is very great, it is best to braze it with spelter solder. We know of the introduction of this kind of joint quite extensively. A joint made in this manner will last a great many years. Care should be observed in tightening the bolts so as not to break the flange on the pipe.

(5) G. J. G., Baraboo, Wis., inquires: 1. Can you tell me of any metho l of obtaining the true position of the bridge or saddle pin of locomotive links, so that it will cut off r ght without a model or sliding-bridge pin? 2. Which contains the most water, one cubic foot of steam at 80 lbs. pressure or one cubic foot of steam at 10 lbs. pressure? 3. Can you increase the pressure of steam by heating (say one cubic foot of steam at 10 lbs. pressure, placed in a suitable apparatus for heating), could you raise the pressure to 20 or 30 lbs.? Please answer through the columns of your journal. A. 1. The rul · that you desire is worked by a templet, and involves a complication hard to understand, and this rule makes no provision for the variations caused by lost motion. All the locomotive builders have established their standards by the "*Rule of Thumb,*" or actual experiment with the valve motion. The adjustment is governed by the general construction of the link motion. 2. One cubic foot of steam at 10 lbs. pressure. Steam becomes more dry as the temperature rises. 3. Yes; but we would advise the person trying this experiment to make the heating apparatus very strong and keep a good distance from it, as steam, when super-heated to the point where it becomes absolutely dry, produces a gas which is uncontrollable. It is also very little understood, and is one of the mysteries connected with boiler explosions.

(6) J. W. L., Dallas, Texas, asks: Please let me know the method of casting plain finger rings of silver or baser metals; also furnish me with a receipt of imitation nickel-plating for table knives, forks and spoons, that could be practiced by immersion by heating the metals and dipping the articles to be plated into the composition. I have such a receipt but cannot get it to work. It consists of block tin, antimony and a small quantity of nickel. You will confer a favor by enlightening me on the subject. A. Finger rings are not cast, but rolled, then bent and the ends soldered together, as the casting process would be too expensive, on account of so many different sizes. We know of no imitation nickel-plating which would give satisfaction. The compound that you speak of is difficult to make (unless you understand the nature of metals), on account of the wide difference between the fusing points of the substances. Nickel melts at 2,800 degrees Fah., antimony at 810 degrees and tin at 442 degrees. The nickel must, therefore, be melted first in a crucible, add the antimony, then the tin. The articles to be coated with this mixture must be thoroughly cleaned, and some acid used to create an affinity between the two metals.

(7) J. R. W., Buffalo, N.Y., writes: Please give me the rule, through your columns, for figuring out compound gears for cutting odd, even and fractional threads; the lead screw being four threads per inch. Do you know of a work on the subject and price? By answering the above you will oblige a subscriber. A. Rule:—Divide the pitch required by the pitch of the leading screw, the quotient will give the proportion or ratio between the first driving gear and the gear on the end of leading screw; or divide the number of threads in a given length of the screw which is to be cut by the number of threads in the same length of the leading screw attached to the lathe, and the quotient is the ratio that the wheel on the end of the screw must bear to that on the end of the lathe-spindle. For compound gears, all that is further necessary is to fix upon any three wheels at pleasure, as those for the spindle and stud wheels, then multiply the number of teeth in the spindle-wheel by the ratio of the screw, and by the number of teeth in that wheel or pinion which is in contact with the wheel on the end of the screw. Divide the product by the stud-wheel in contact with the spindle-wheel, and the quotient is the number of teeth required in the wheel on the end of the leading screw. Should this give you a result with which you can find no gear to compare, your judgment will lead you to select other wheels which may be worked in the same way until you find out the right. Table for engineers and mechanics, giving the values of the different trains of wheels required to produce screws of any pitch, calculated by Lord Lindsay, M. P., 8vo., oblong, 80c.

LITERARY NOTES.

A PRACTICAL TREATISE ON THE COMBUSTION OF COAL. By William M. Barr. Published by Yohn Brothers, Indianapolis, Ind. Price $2.50.

This work is divided into 18 chapters, contains 307 pages octavo.

Nearly every day brings something new to our minds in the way of unmistakable evidence, which proves that theory and practice are working more together as time advances.

One of these evidences is a new book by Mr. Barr, which bears the above title. The following subjects are thoroughly discussed in this work:

The Atmosphere; Fuels; Analysis of Coal; Combustion; Air required for Furnace Combustion; The Furnace; Products of Combustion; Thermal Power of Fuels; Heat; The Construction of Furnaces; Mechanical Firing; Spontaneous Combustion of Coal; Coal-Dust Fuel; Liquid Fuel; Gaseous Fuel; Utilizing Waste Gases from the Furnaces; A Ponsard's Process and Apparatus for Generating Gaseous Fuel, etc., etc.

It is by far the most plain practical work on this subject that has ever come under our notice, and the author has done honor to himself in uniting his utiring efforts with those of the very few who have made repeated and successful attacks upon the theories which, like clouds, have heretofore hung over the horizon of practice. By carefully avoiding technical terms, and retaining scientific principles, he has made the book equally as useful to the theoretical engineer as to the practical mechanic. Every manufacturer using a boiler will do well to read it, for he will be sure to profit by adopting some of the common-sense suggestions on the economic generation of steam.

The information contained in the work is in reality the cream of over thirty-five of the best authors on the subject, from which Mr. Barr has taken extracts, which, when put together form a work for every-day study, and reference not easily dispensed with.

The author, himself, is justly regarded as high authority on the subjects he discusses in his work, having at one time been Superintendent of the Atlas Works.

A SUPPLEMENT TO SPON'S DICTIONARY OF ENGINEERING, CIVIL, MECHANICAL, MILITARY AND NAVAL. EMBRACING ALL THE MODERN INVENTIONS AND IMPROVEMENTS MADE SINCE THE PUBLICATION OF THE ORIGINAL DICTIONARY. E. & F. N. Spon, 446 Broome St, N. Y. 75 cts. per number. [Numbers 1, 2, and 3 of this work are now out, and the whole is to be completed in about 15 monthly parts.]

Among the important additions may be noticed the most approved forms of registering passengers, fare counters, and speed recorders adapted to railroads, which make their own diagrams. The part devoted to Agricultural implements is very complete, while the department devoted to compressed air is handled in a plain and practical way. This work contains some valuable information in regard to the manufacture of animal charcoal, and also some reliable data in relation to the use of belting, pulleys, etc.

There is also an abundance of information on blasting, mode of applying the charge so as to get the greatest effect, and firing the same by electricity, with appropriate aparatus.

This work will no doubt find a ready welcome among those who possess a copy of the original dictionary, and is a valuable addition.

NEW ENGLAND BUSINESS DIRECTORY, 1879 No. IX. Sampson, Davenport & Co., Boston. Price, $6.00

This valuable commercial guide, which is issued every two years, has lately made its appearance for 1879. It contains over 1,500 octavo pages, and embraces a complete business directory of each of the six New England States corrected to date, and a full directory of the city of Boston. There is also a directory of the manufacturing companies of New England, the savings banks, gas companies, and other special information. Included in the work is a fine map of New England. It is the most complete and convenient work of its kind that has come to our notice.

MANUFACTURES.

The Rogers' Locomotive and Machine Co., of Paterson, N. J., employ about 550 men, and have not yet built up the part of their factory which was destroyed by fire some time since. They are full of orders, and have closed a contract for twelve locomotives within the last week for the West. Most of the other work is for exportation. Work is given out by the piece, generally, and the capacity of the works at present is one locomotive per day, or forty per month. Prospect very encouraging.

The Passaic Rolling Mill Co., of Paterson, N. J., employ 600 men, and have a contract to take down and rebuild the old New York Elevated Railroad, from the Battery to 12th Street. They also have several contracts for bridges for exportation to South America, besides others for the United States. All the iron used is made on the premises, and the capacity of the rolling-mill is forty tons per day. The pay-roll amounts to about nine hundred dollars per day, or about ten thousand dollars every two weeks.

The Danforth Locomotive and Machine Co., of Paterson, N. J., employ 460 men, and are executing a contract for ten locomotives for the Metropolitan Elevated R. R. of this city. Two have already been shipped, and others will be ready soon. They also have other small contracts for locomotives and silk machinery.

The Grant Locomotive Works, of Paterson, N. J., employ about 500 men, and are finishing a contract for forty locomotives for the N. Y. L. E. & W. R. R. They are doing a very fair business, with good prospects. Have some small orders for locomotives, besides some looms for weaving wire. Capacity of works is two moguls or three passenger engines per week.

The Union Bolt Works of Paterson, N. J., employ 120 men; are full of orders and have prospects of a good summer's trade.

Benjamin Eastwood, Paterson, N. J., employs 22 men; has plenty of work and steadily increasing. Silk machinery a specialty.

The Watson Machine Co., of Paterson, N. J., employ a large force of men, and are very busy on general machinery. Business is steadily increasing.

J. Nussey & Co., of Paterson, N. J., employ 25 men, and are doing a very fair machinery business.

Juan G. Ribon, of Jersey City, N. J., is quite busy on small machinery orders, most of which are for exportation to South America.

David W. Pond, Worcester, has adopted a new device for clamping the rest to the bed of lathes while cross-feeding, which avoids straining or springing the parts.

Wm. Allen & Sons, Worcester, are putting in a Victor Feed Water Heater for the New Haven Gas Co. They have put in one large No. 12 Heater (600 h. p.) to run with live steam, for the Holly Steam Combination Co., Lockport, N. Y. This is taking out lime and other impurities. They have lately put in a heater for Sweet's M'f'g Co. Syracuse, N. Y., displacing a popular heater of another make, also one No. 10 (300 h. p.) in the mills of the Hartford Carpet Co. One has just been sent to C. H. Hawes, Dayton, O., and two more are ordered from the same city.

The Nicholson File Co., Providence, are erecting an addition to their works. One building is to be 15×40 feet, another 110×44 feet, and a third 60×52 feet, all of brick.

The Central Pacific R. R. Co. has just ordered of the Pratt & Whitney Co. 1500 taps of different varieties, after making a thorough trial of their taps.

The E. Horton & Son Co, Windsor Locks, Conn., report business in chucks improving nicely. They are having a great many orders from England.

The Hendey Machine Co., Wolcottville, Conn., have a force of twenty-four men on full time, with a good supply of orders ahead.

The Stiles & Parker Press Co., Middletown, Conn., have just moved into their new shops. One building is 110×34 feet, two stories high; the foundry is 93×50 feet, the blacksmith shop 26×34 feet, the engine room 24×30 feet, the boiler room 40×15 feet, and the pickle room 24×26 feet. The grounds contain nearly two acres. They are now employing about fifty men.

W. H. Warren, Worcester, has just made three die-slotting machines with angular, circular, and conical motions. They are of an entire new design, and are to be used in hardware factories for working out dies. He is now building eight special machines and is crowded with work.

The following mills in Fall River are setting over boilers with the Jarvis Patent Furnace: American Linen Co., Chace Mill, Osborn Mill, and Narragansett Mill.

Winslow Bros., Norwood, Mass., are setting a steel boiler, built by the Whittier Machine Co., with the Jarvis Patent Furnace.

The Boston Dyewood & Chemical Co., are setting a new boiler at East Boston with the Jarvis Furnace; also resetting an old boiler the same way, at their works in Hanover, Penn.

The Billings & Spencer Co, Hartford, are running full with sixty hands, and can hardly keep up to their orders. Their new pocket wrench keeps a good part of the force busy. For drop forgings and lathe dogs they are securing an unusual number of orders from all parts of the country.

R. Dudgeon, New York, has just completed two large steam hammers, one for the National Tube Works, and the other for St. Johns, N. B. He is just finishing one for Garner & Co. He is sending large quantities of his tube expanders abroad.

Personal.

Jerome Wheelock of Worcester has gone to Europe for two or three months to aid parties he has licensed to build the Wheelock Steam Engine in getting properly started.

Prof. R. H. Thurston is rapidly recovering his health, and we trust before many more months to see him in his active duties at the Stevens Institute of Technology.

Richard Dudgeon, of this city, who came home from England the first of this year in ill health, has been on his farm ever since and is recovering at a satisfactory rate.

Proposals for erecting a fifteen million gallon pumping engine, with present boilers, for the city of Brooklyn, to be completed and working by December 1, were responded to by bids as follows: Norman Hubbard, for the sum of $89,800; Freel & McNamee, for the sum of $53,500; Henry R. Worthington, for the sum of $100,000; N. F. Palmer, Jr. & Co., of the Quintard Iron Works, for either of the sums of $99,250, $91,250 and $106,750, with certain guarantees in each case; Arthur J. L. Loretz, for the sum of $57,750; John S. Hunter, President Hartford Foundry and Machine Co., for the sum of $67,215; George Whitaker, for the sum of $75,950.

Machinists' and Engineers' Supplies.

Whatever croakers may say, there is an unmistakable improvement in business, both in volume and strengthening of prices. Dealers stock up with standard goods with more confidence than at this season for five years past, and manufacturers are to be congratulated in the improved outlook.

The manufacturers of rubber belting, steam packing, hose and engineers' rubber supplies, have perfected a permanent organization, with J. H. Cheever, of New York, for President. They have held several meetings with a view to advance prices to a uniform scale. The last meeting was held June 17th, but did not reach any definite agreement.

E. N. Boynton, Worcester, Mass., has just issued an illustrated catalogue and price list of combined upright and horizontal self-feeding drills, breast and feed drills, tire benders, bolt cutters and shaping machines. These drills have been sold extensively, not only in this country, but largely abroad.

James D. Foot, 40 Broadway, New York, sole agent for Weinman & Kearney's Hand Cut Files, has issued a circular, in which we find the following sensible notes under the heading, "A few words about Files:"

"A new file should always be used with a light pressure on the work till the needle-like points of the teeth are worn away; after this, a much heavier pressure may be used with much less danger of breaking off the teeth at their base. Many new files are violently diminished half their efficiency by a few careless strokes when first applied to the work.

"Do not use a new file on the chilled and gritty skin of castings, or on a weld where borax or any vitreous fluxes have been employed—no file can endure such usage.

"Every filer should be required to keep a worn file with which first to attack the rough, gritty or oxydized surface of iron work, and thereby pave the way for a more efficient work with his sharp files. A piece of gritty or chilled casting that would rapidly destroy the cutting qualities of a new file, would produce scarcely any damaging effect to a worn one.

"In filing steel, better results can generally be obtained by using files of a grade not coarser than "2d cut;" finer grades being employed according to the finish and delicacy of the work under manipulation.

"Parties using files should always seek to discover the fitness or adaptability of cut and form of files specially suited to their work. No one should expect the best results from a file on brass or spelter which was intended for use on iron or steel.

"Consumers of files should see that they are furnished by the dealer or manufacturer with the full weight article. This is always a desideratum, and especially in case re-cutting is desired. A full weight file can be re-cut two or three times, while a light weight will hardly bear one re-cut and give satisfaction."

Mr. W. S. Middleton has just started a machinist's and railroad-supply business at 52 John Street, New York. Mr. M has been in the trade for several years, and is well acquainted with its details.

The New York Twisted Drill Co., 240 Plymouth St, Brooklyn, have lately placed upon the market a line of forged and twisted Drills made by a new process. After a year spent in experimenting and devising special machinery to make these drills, they are prepared to turn out a product possessing special features of merit. Their Drills are all twisted, not cut, and the lip is claimed not to break or split. The hammering which the steel receives in forming the shape of the Drill closes up the center and makes it peculiarly strong. As will be observed, the process of forging, instead of cutting, leaves the surface of the metal tougher and better suited to the work drills are required to do. This process also requires less stock. These drills have no increase and each part does the same work as any other part. They guarantee that the lip cannot split if properly ground. These drills have been used by a number of large machine shops in this city and vicinity with excellent success. The company has a well-arranged shop and facilities for turning out a good amount of work.

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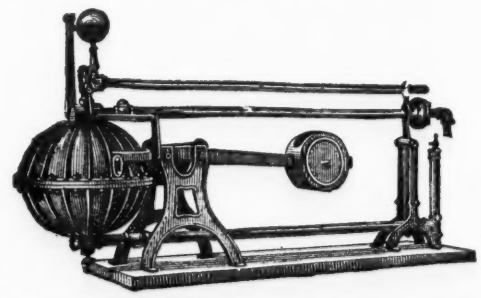

This Trap automatically drains the water of condensation from HEATING COILS, and returns the same to the Boiler, whether the Coils are *above or below* the water level in Boiler, thus doing away with pumps and other mechanical devices for such purposes. Apply to

Albany Steam Trap Co.,
ALBANY, N. Y.

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SOLE MANUFACTURERS OF

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ALSO,

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"NICHOLSON FILE CO.'S" FILES AND RASPS,
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Communications by letter will receive prompt attention.

Jacks for Pressing on Car Wheels or Crank Pins made to order.

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FOR SETTING

STEAM BOILERS.

Economy of Fuel, with increased capacity of Steam Power.

The same principle as the SIEMANS' PROCESS OF MAKING STEEL *i. e.*, utilizing the waste gases with hot air.

Will burn all kinds of waste fuel without a blast, including screenings, wet peat, wet hops, sawdust, logwood chips, horse manure, &c.

A. F. UPTON, General Agent,

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THE BEST STEAM PUMP in AMERICA

THE DEANE.

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DEANE STEAM PUMP WORKS,

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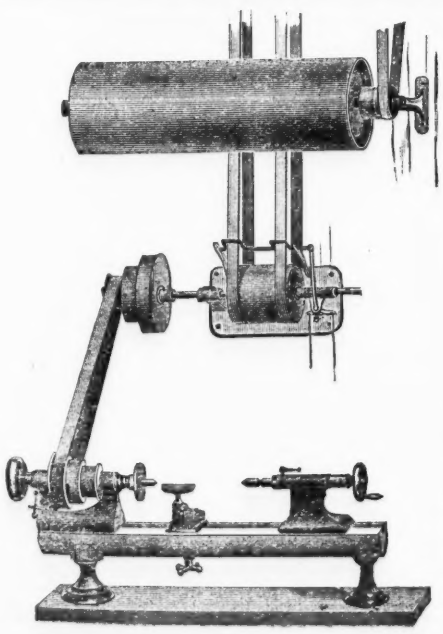

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The accompanying cut shows our No. 3, or Machinist Bench Lathe, with its driving counters for lathe, and its grinding attachments. This lathe was originally designed for the American Watch Co., and has been adopted by all American watch companies and by many clock companies of this country, and watch companies of England and Switzerland. All agree in pronouncing it the best Lathe for small work ever made.

Newell's Patent Universal Grinder.

IMPORTANT TO MILLERS, MINERS AND MANUFACTURERS.

This Grinder is offered to the public as a machine which has no equal for grinding grain or pulverizing quartz, phosphates, bone, cement, oyster shells, scraps, glue, fire clay, and other articles of similar nature. It is unrivaled in the amount of work it will do in any given time and in the economy of power used. It is a point of great merit that our mill delivers a perfectly ***GRANULATED*** article. In grinding grain the meal ***IS NOT HEATED,*** and consequently may be bagged at the delivery spout with no danger of fermentation, and without the loss of weight incidental to the product when heated in grinding. It is estimated that the usual shrinkage is sufficient to cover the entire expense of grinding by this mill. We have ground, bolted for fine feed, through 13 mesh, weighed and bagged up ***six thousand five hundred (6500) pounds of corn per hour*** with not more than 15-horse power. It is compact, portable and not expensive. A cordial invitation is extended to all parties to call and see the machine at work at

Foot West 19th Street, New York City.

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An invaluable substitute for forgings or cast iron requiring three-fold strength.
Gearing of all kinds, Shoes, Dies, Hammerheads, Crossheads for Locomotives, etc.
12,000 Crank Shafts of this steel now running proved superior to wrought iron.
CRANK SHAFTS, CROSSHEADS and GEARING specialties.
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N. B.

The following original articles, by twelve of the best mechanical authors in the U. S., appeared in the *American Machin'st* of the dates mentioned below. Copies containing these articles can be ordered from any newsdealer at 6 cents each.

Sizes of Safety Valves.
Prof. R. H. Thurston. December, 1877.

Methods of Setting Boilers in Brick-Work.
Theron Skeel. December, 1877.

Boiler Explosions.
Stephen Roper. April, 1878.

Strength of Steam Boilers.
John W. Hill. July, 1878.

The Properties of Water.
John W. Hill. August, 1878.

Balance Pulleys.
Geo. M. Chordal. August, 1878.

Piston Speed of Engines.
Wm. Lee Church. September, 1878.

Composition of Fuel.
John W. Hill. September, 1878.

To Prepare a Shaft Properly for Turning.
J. J. Grant. October, 1878.

Practical Method of Setting the Valves of a Locomotive.
L. F. Lyne. November, 1878.

Boring Locomotive Cylinders.
L. F. Lyne. December, 1878.

Grinding and Polishing Metal Surfaces by Hand.
Thos. Hagerty. December, 1878.

To Turn a Shaft Properly.
J. J. Grant. December, 1878.

Engineering Popularized.
Wm. Lee Church. January, February, March, April and May, 1879.

Calculated vs. Actual Engine Duty.
W. H. Odell. January, 1879.

The Injector as a Means of Raising Water.
Wm. J. Williams. February, 1879.

Engine Duty and Indicator Cards.
Chas. A. Hague. April, 1879.

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(INDEX CENTRES.)

Fit any machine. As shown on page 3 March number AMERICAN MACHINIST.

Boston Nut Co., BOSTON.
MANUFACTURERS OF CASE HARDENED NUTS.

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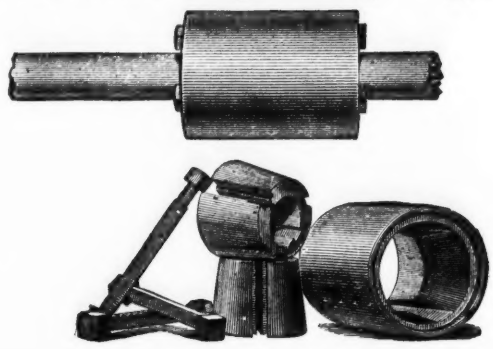

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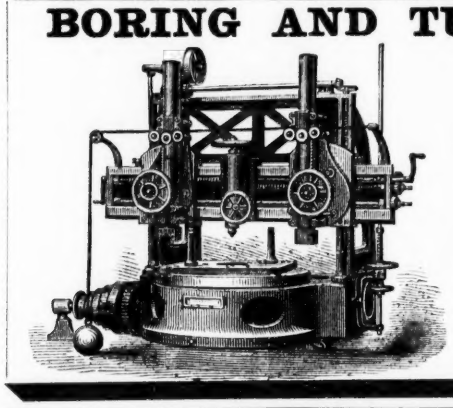

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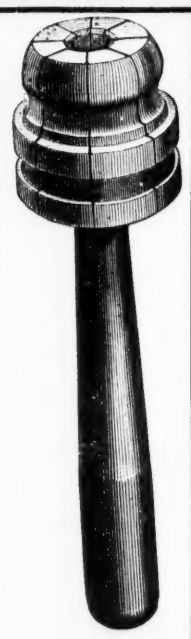

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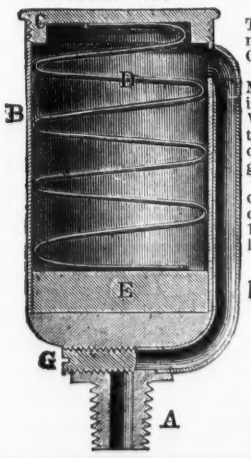

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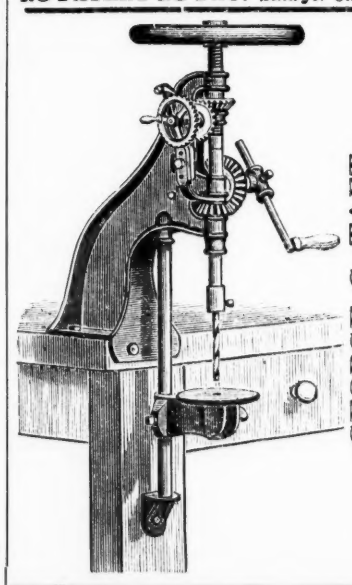

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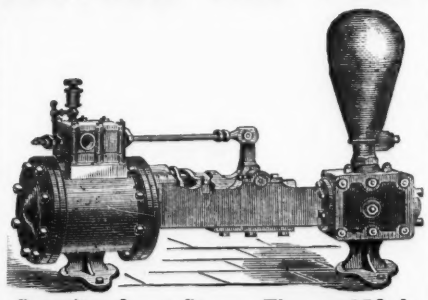

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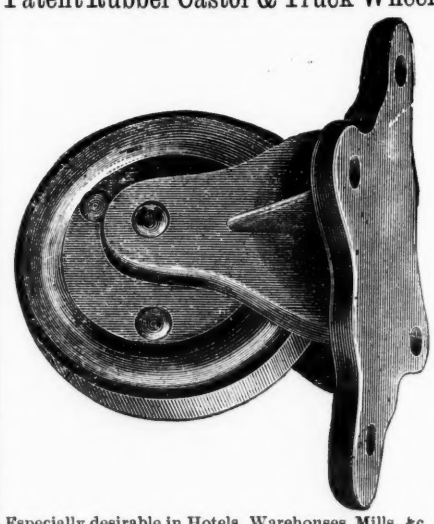

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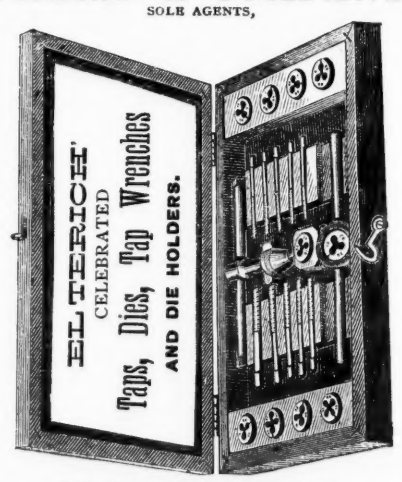

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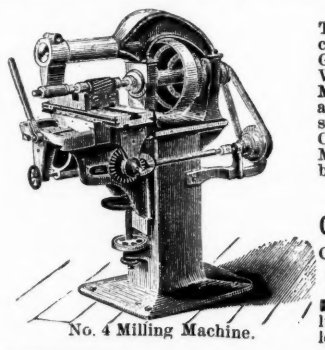

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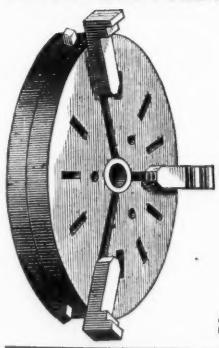

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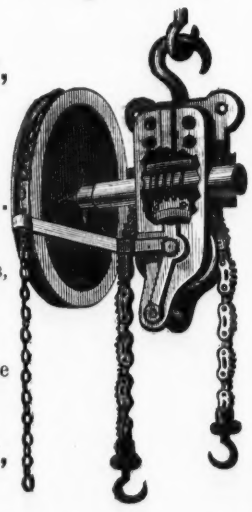

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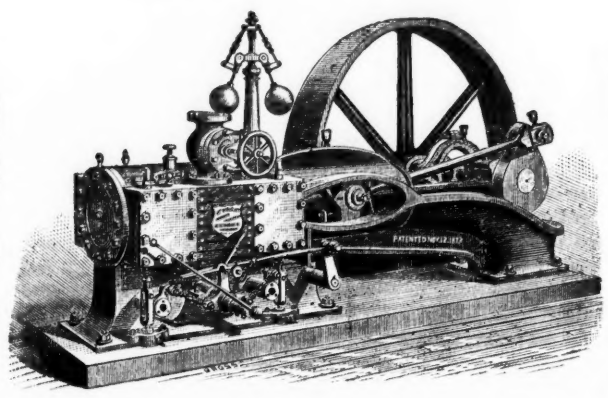

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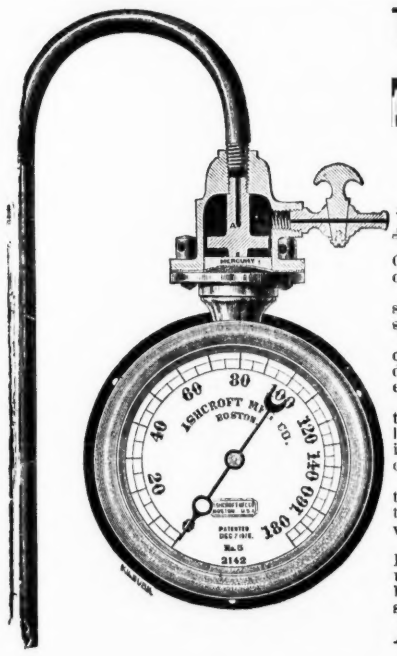

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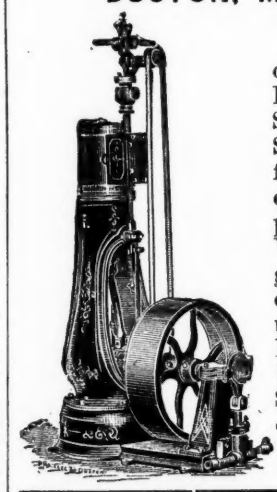

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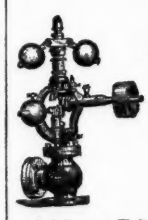

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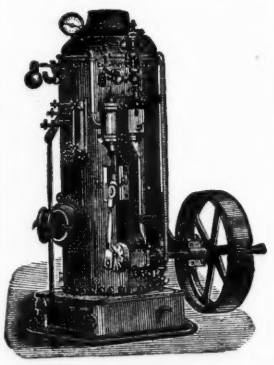

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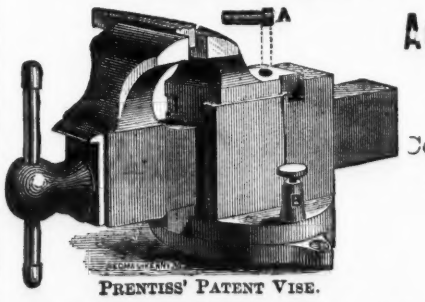

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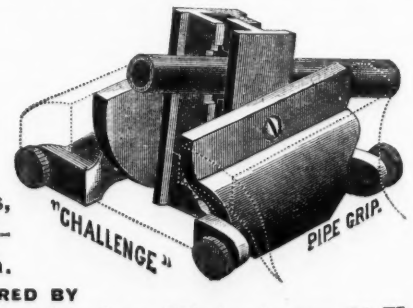

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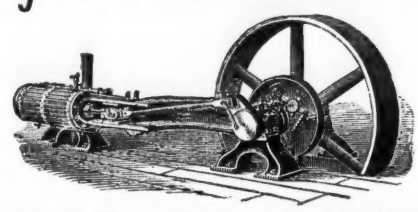

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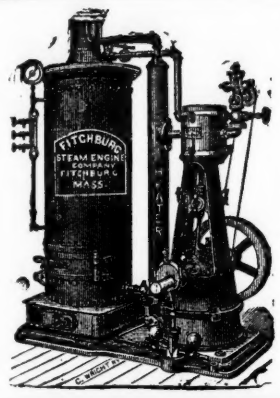

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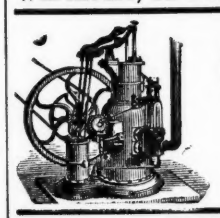

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Six Engine Lathes, 20 in. swing, 7½ ft bed.
Five Engine Lathes, 20 in. swing, 8 ft. bed.
One Engine Lathe, 21 in swing, 6 ft. bed.
One Engine Lathe, 21 in. swing, 16 ft. bed
One Engine Lathe 24 in, swing, 12 ft. bed.
One Engine Lathe, 28 in. swing, 12 ft. bed.
Two Upright Drills, 27 in. swing, not geared.
One Upright Drill, 22 in. swing, not geared.
Two Planers, 32 in. x 30 in. x 8 ft.
One Planer, 32 in. x 30 in. x 10 ft.
One Planer, 37 in. x 37 in. x 10 ft.
One Planer, 42 in. x 36 in. x 15 ft.
One Planer, 72 in. x 66 in. x 24 ft.
One Shaping Machine, 12 in. stroke.
Four Bolt Cutters, various sizes.
One Horizontal Boring Lathe.

The following are all new tools to be sold very low, and are all Wood, Light & Co.'s make.

Four Engine Lathes, 16 in. swing, 6 ft. bed.
One Engine Lathe, 20 in. swing, 20 ft. bed.
Two Planers, 24 in. x 24 in. x 6 ft.
Three Shaping Machines, 11 in. stroke.
One Shaping Machine, 14 in. stroke.
Seven No. 2 Bolt Cutters.
One No. 1 Bolt Cutter with centers.
Five No. 2 Bolt Cutters, with centers.

Also the following miscellaneous Tools:

One No. 2 Pratt & Whitney Screw Machine with wire feed.
One No. 3 Stiles Press.
One Portable Engine, 6 in. cylinder.
One Hand Milling Machine.
One "Pond" Index Milling Machine.
Three Chase Patent Pipe Cutting Machines.
Two Engine Lathes, 15 in. swing, 6 ft. bed. Two Engine Lathes, 22 in. swing, 8 ft. bed. One Engine Lathe, 15 in. swing, 6 ft. bed. Three Engine Lathes, 20 in. swing, 8 ft. bed. Six Turning Lathes, 14 in. swing, 4½ ft. bed Three 4-spindle Drills. One 8 in. Shaper. One Gear Cutter. One new "Hardaway" Bolt Heading Machine, to head up to ⅞ in. bolts. One new "Hardaway" Bolt Heading Machine to head up to 1¼ in. bolts. A lot of Saw Tables and Wood Working Machinery.

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One pair of 12 in. Planer Centers.
One Engine Lathe, 21 in. x 9 ft. taper and cross feed.
Two " " 13 in. x 5 ft. " attach.
One " " 13 in. x 4 ft.
Two " " 13 in. x 5 ft. not bk. geared or screw cutting.
One Hand Lathe, 15 in. x 8 ft.
One Cutting-off Lathe, 1¼ hole through Spindle.
One Upright Drill, 24 in. with bk. gear and self feed.
One No. 0, 2 Spindle Drill.
Two No. 0, 3 " "
One No. 1, 3 " "
One No. 3, 4 " " 2 Spindles geared for heavy work.
One No. 1, Power Milling Machine.
Two No. 2, or Lincoln Pattern Milling Machine.
One No. 2, Hand Milling Machine.
One Cutter Grinder.
One No. 3, Screw Machine.
One No. 2, " " wire feed.
One No. 0, " " " "
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One Double Cam Cutting Machine.

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" 1, One 36 in. x 16 ft. Engine Lathe, bk. geared, screw feed, comp'd rest, cross feed, etc.
" 15, One 26 in. x 12 ft. Engine Lathe, bk. geared, screw cutting, rod feed, comp'd rest, cross feed, etc.
" 4, One 25 in. x 12 ft. Engine Lathe, bk. geared, screw cutting, rod feed, cross feed, etc.
" 3, One 20 in. x 12 ft. Engine Lathe bk. geared, screw cutting, rod feed, Gib rest, etc.
" 8, One 20 in. x 8½ ft. ditto.
" 9, One 20 in. x 8½ ft. "
" 10, One 20 in. x 8½ ft. "
" 13, One 20 in. x 8½ ft. "
" 5, One 18 in. x 10 ft. "
" 7, One 18 in. x 8½ ft. "
" 11, One 18 in. x 8½ ft. "
" 12, One 18 in. x 8½ ft. " (cross feed.)
" 16, One 16 in. x 8 ft. Engine Lathe, bk. geared, screw cut'g, rod feed, cross feed, Gib rest.
" 17, One 16 in. x 8 ft. Exactly same.
" 18, One 16 in. x 8 ft. Same, except cross feed.
" 23, One 16 in. x 10 ft. Engine Lathe, bk. geared, screw cut'g, rod feed, Gib rest, etc.
" 24, One 16 in. x 8 ft. ditto.
" 19, One 16 in. x 6 ft. " (W't rest).
" 20, One 16 in. x 6 ft. " "
" 21, One 16 in. x 6 ft. " "
" 25, One 16 in. x 6 ft. " "
" 26, One 16 in. x 6 ft. " (Gib rest).
" 27, One 16 in. x 5½ ft. " (W't rest).
" 28, One 16 in. x 10 ft. Gib rest, rod feed, (not screw cutting) bk. geared.
" 29, One 16 in. x 10 ft. Same as No. 28.
" 38, One 16 in. x 6 ft. (W't rest), bk. geared, screw cutting, rod feed.
" 39, One 16 in. x 6 ft. ditto.
" 30, One Hand Lathe, 14 in. x 10 ft.
" 79, One " 13 in. x 5 ft.
" 49, One " 14 in. x 6 ft.

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" 73, One Planer, to plane 24 in. x 24 in. x 6½ ft., down, cross and angle feed in the head.
" 66, One Planer, to plane 24 in. x 24 in. x 6 ft., down, cross and angle feed in the head.

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" 52, One 17 in. " "
" 62, One Post Drill.
" 63, One 32 in. W., L. & Co. Drill, bk. gear, self feed.
" 64, One 48 in. " " "
" 51, One 26 in. Ferris & Miles' Drill, self feed, quick return.
" 61, One 27 in. ditto.

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One " " 12 " "
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One Wood & Light Milling Machine.
One Brainard Milling Machine, No. 8.
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One Smith & Garvin No. 3. Miller. New.
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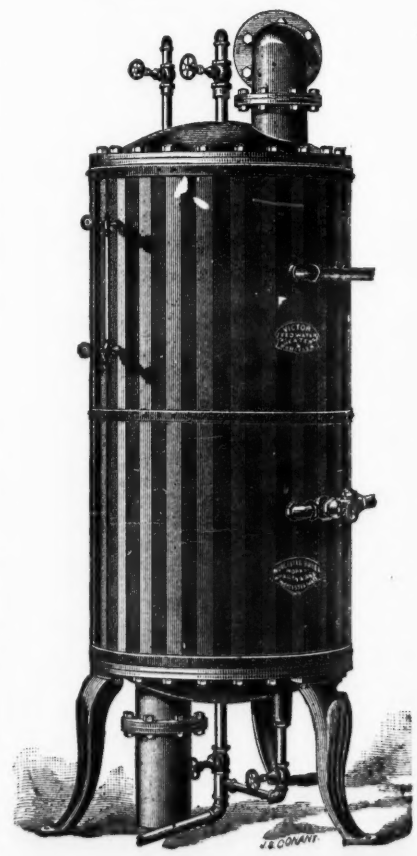

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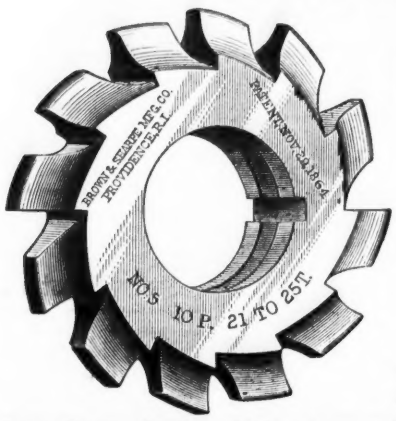

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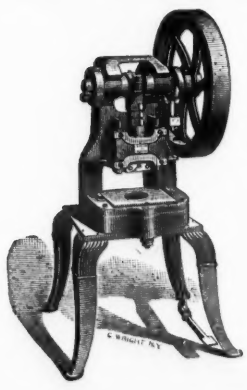

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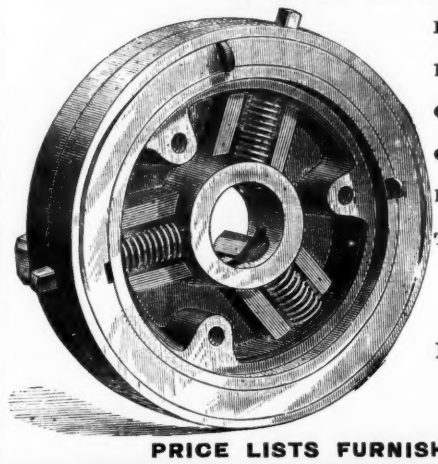

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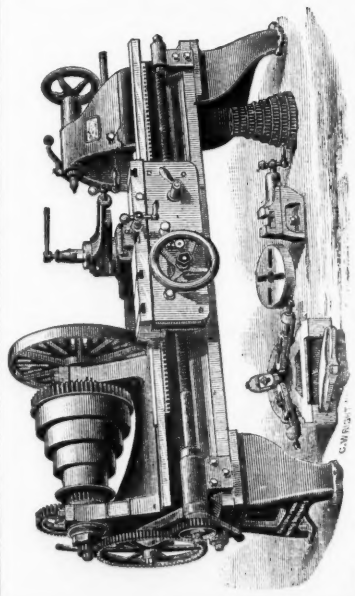

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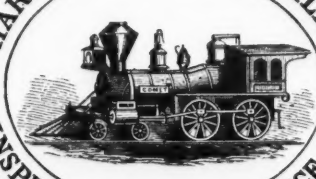

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